JOURNAL
OF THE
FRANKLIN INSTITUTE
OF THE
State of Pennsylvania,
AND
MECHANICS' REGISTER.

APRIL, 1838.

Practical and Theoretical Mechanics and Chemistry.

On Hydraulic and Common Mortars. By General TREUSSART, *Inspecteur du Genie. Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(CONTINUED FROM P. 166.)

ARTICLE XII.—*Of mortars made of Hydraulic lime and sand, or of Hydraulic lime and Puzzolana.*

After I had become acquainted with the good qualities of the Obernai hydraulic lime, I used it not only for works in water, but also for masonry in the air. It required some patience to change the habits of the workmen, and to bring them to the use of other means than those they had been accustomed to apply to the slaking and management of fat lime; but I was ably seconded by Lieut. Col. Finot of the Engineers, who was charged with the immediate superintendence at Strasburg; and, thanks to his efforts, all the persons employed soon became familiar with the manner of treating hydraulic lime, and excellent results were obtained.

In the observations made by Mr. Vicat on the pamphlet published by me in 1824, he thus expresses himself: "Mr. Treussart pretends that hydraulic limes are only made in order to obtain mortars which will harden in water: so far from that being the case, it may, on the contrary, be said, that hydraulic limes (when the country does not furnish them naturally) are made only because mortars composed of these limes and common sand are, at the same time, the most economical and the best, that have yet been discovered, to brave the inclemences of the weather, resist the alternations of hot and cold, wet and dry, &c."

It is true that at page 46 of my pamphlet I said "The author observes that hydraulic limes are made only to compose mortars which have the property of hardening in water. Since this result is obtained, directly, with fat lime and factitious trass, and the results thus obtained are the best, he thinks this mode the most advantageous." This passage cited independently, might lead to error: but, as in all that preceded, the question was, only, as to works in water, it means that when there are works to be built in water, it is necessary to produce hydraulic mortars; and that when there

is not, on the spot, natural hydraulic lime, it is preferable on all accounts, to make hydraulic mortar of fat lime and factitious trass, instead of making artificial hydraulic lime according to the process of Mr. Vicat. I did not in the pamphlet of 1824, give details as to the manner of employing hydraulic lime in the air, because I had not then facts enough to warrant it; but I did not say that they might not be employed with advantage in constructions in the air: very far from that—for my experience having taught me, on several occasions, how dangerous it is to use in the air hydraulic lime that has been too much burned (and I may add that it is as dangerous in the water) I said, speaking of hydraulic limes, at page 5 of the pamphlet, that, "if they are used in the air when too much burned, they may occasion very serious accidents, because they dilate considerably, and may heave up very large stones; it is therefore important to employ this lime only when it is calcined just enough." We see therefore that I was far from thinking that we should not use hydraulic limes in the air: but that I thought it my duty to notify that they must not be made use of when too much burned, because of the serious accidents that might result. If this observation had been attended to, the works of the *Vésére* would not have sustained the serious accidents that obliged them to rebuild several Locks. At Strasburg, care was taken to reject such pieces as were too much burned; and although it often happened that mortar of the ordinary consistency, made of lime just from the kiln, was used, no serious accident befel.

All the officers of the Corps of Engineers are acquainted with Metz, and know the good quality of its hydraulic lime—there used in air as well as in water. I have, myself, used the lime under several circumstances; and, as I observed in the first section, there was built at Strasburg, under my direction from 1816 to 1825, more than a million of masonry, both in air and water, of hydraulic lime. Mr. Vicat was, therefore, altogether deceived as to the sense of the phrase which he quoted; he, moreover, has himself said nearly the same thing: for, in commencing the second section of his work, he says, page 31, "hydraulic mortars, as the name indicates, are designed for masonry to be placed in water: they are also called betons." Were this phrase cited alone, we might apply to Mr. Vicat the reproach he directs to me. I do not think that Mr. Vicat wished us to understand that this lime should not be used in the air; because every body knows that it may. Not only do I think that hydraulic mortars are the best to be used in constructions in the air; but—much more than that, my labours have led me to think that, with fat limes, moderately good mortars cannot be made, in whatever manner treated, if no hydraulic cement be added to them: which is saying, in a word, that the sole means of obtaining good mortars in the air, is to use only hydraulic mortars. The only essential point in which I differ from Mr. Vicat is, that I think—as in mortars for the water, it is preferable to make the hydraulic mortar, directly, with fat lime and factitious puzzolana or other like substance, instead of making hydraulic lime by the process he has indicated, when in a country where there is none naturally good. This method has, besides, the advantage that in countries where the lime is only moderately hydraulic, the mortar may be sensibly meliorated by adding a small quantity of hydraulic cement and a greater quantity of sand, (which would be but a small expense;) while according to the process of Mr. Vicat, it would cost as much to improve, suitably, the moderately hydraulic lime thus at command, as to produce the entire conversion of fat lime into hydraulic lime.

I shall give, in the following tables, results which I obtained with differ-

ent hydraulic limes from the environs of Strasburg, Metz, and other places.

Table No. XXXV.

No. of the mortars.	Composition of the mortars.	made immediately.	After 15 days	After 1 month.	After 2 months	After 3 months	After 4 months.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1	Yellow Obernai slaked to powder and measured in powder 1 / Sand 2 } 3	99	110	132	99	77	66
2	Same lime 1 / Sand 1 / Trass 1 } 3	231	242	262	246	246	220
3	Same lime air slaked and measured in powder 1 / Sand 2 } 3		77	44	55	44	44
4	Same lime 1 / Sand 1 / Trass 1 } 3			231	253	262	253
5	Metz lime slaked to powder and measured in powder 1 / Sand 2 } 3	114		88	44		
6	Same lime 1 / Sand 1 / Trass 1 } 3	268		231	220		
7	Same lime air slaked and measured in powder 1 / Sand 2 } 3			66	40		
8	Same lime 1 / Sand 1 / Trass 1 } 3			242	253		
9	Another Obernai lime slaked to powder and measured in powder 1 / Sand 2 } 3	220	121	88	77	66	
10	Same lime 1 / Sand 1 / Trass 1 } 3	264	264	286	297	275	
11	Same lime air slaked and measured in powder 1 / Sand 2 } 3		88		55		
12	Paris hydraulic lime slaked to powder and measured in powder 1 / Sand 2 } 3	187		121			
13	Common lime reburnt with 2-10 of Holsheim clay, slaked to powder and measured in powder 1 / Sand 2 } 3	176		110	88	55	44

Observations on the experiments of Table No. XXXV.

All the experiments of this table were made with lime that had been slaked to powder with one-fifth of its volume of water: and the proportions were, one part of lime in powder to two parts of sand.

The first four mortars of the series were made of the same Obernai lime as those of table No. VI which were put into water. No. 1 was composed of lime and sand. If we compare its resistance with that of the like mortar of table No. VI, we shall see, 1st. that the piece of lime which, with sand, produced mortars of feeble consistence in the water, has also given

feeble results in the air (it appears that the piece of lime was but slightly hydraulic:) 2d. that the tenacity of the mortars has, alike in both cases, augmented for a certain length of time, after which it rapidly decreased: 3rd. that the mortars left in the air, have generally given a weaker resistance than those placed in water.

Series No. 2 was made of lime, sand and trass, in equal parts. The result we see is much meliorated. The resistance went on increasing like the similar mortar of table No. VI. These mortars, also, exhibited less tenacity than those under water.

Series No. 3 was made of the same lime left to slake spontaneously. The proportion was one of lime, in powder, to two of sand. It was not till after fifteen days that I could procure enough lime in powder to commence the experiment. If the results be compared with No. 1, we shall see that lime air-slaked gave resistances much inferior to those obtained with lime slaked by water to powder—as was the case with mortars put under water.

Series No. 4 was made of air-slaked lime, sand and trass, in equal parts. These results being compared with those of the 2nd. series, we see but slight difference: if compared with the like mortars put under water of table No. VI, we see that they are sensibly inferior.

The series No. 5, 6, 7 and 8 shows similar experiments with Metz lime; these mortars are made of the same lime as those of table No. VII, which were deposited in water. The results given by the Metz lime are weak; but it is probable that with this lime, as with others of the like nature, very different results are afforded by different pieces from the same quarry. I am not entitled to say that the Metz lime is inferior to the Obernai lime, not having made experiments enough with the former to be able to compare. The observations made on the first four series of table No. XXXV, apply, generally, to the mortars made of Metz lime.

Series Nos. 9, 10 and 11 were made of the same Obernai lime, as the mortars of table No V which were put under water: the results are good. No. 9 shows that if not made up till it has been slaked fifteen days, this lime loses nearly one half of its force: and that it loses more and more as this period is extended. If we compare the mortar made immediately, with its analogous experiment in table No. V, we shall see that the mortar left in the air supported 44 lbs. less than the mortar left in water. With the other mortars the differences are not so great.

In comparing series No. 10 above, with the corresponding series in table No. V, we find that the mortar made immediately, gave a resistance only about one-half of that of the similar mortar of Table No V; while the mortar No. 2 of the present table, made of another lime, supported a weight rather greater than the similar mortar of table No. VI, which had been put in water. I cannot explain this anomaly. The other mortars of this series, made at different periods, were inferior, or at most only equal to the corresponding mortars that had been put in water.

The series No. 11 comprises only two experiments with lime left to slake spontaneously: these two experiments consumed all the lime. The results are weaker than the corresponding ones of series No. 9 of which the lime had been slaked to powder with water, agreeing in this respect with the comparison of No. 1 and 3 above.

Series No. 12 comprises two experiments only, made of artificial hydraulic lime manufactured at Meudon, by Mr. Saint Leger. Having but a small quantity of lime, I was unable to make a greater number of experi-

ments. The resistance of mortar made immediately, is good: that made at the end of a month has lost nearly half its force. Two mortars made of the same lime and put into water, are given at No. 1 of table No. X. On comparing them we see that the mortar made at once and left in the air, supported the same weight as that put in water. Mortar made of this lime after being slaked a month, gave when exposed to the air, a resistance of 121 lbs. and when plunged into water, only 88 lbs.

Series No. 13 is of mortar made of an artificial hydraulic lime composed of fat lime and Holsheim clay. The result is nearly the same as that of series No. 12. We see that the strength of the mortar diminished rapidly by the exposure of this lime to the air; and that at the end of four months it had lost three-quarters of its strength.

I made but few experiments with artificial hydraulic limes in the air, but those which I did make, show that they differ in nothing from natural hydraulic limes. They show, also, that in the air, as well as in water, better mortars are generally obtained with fat lime, sand, and substances analogous to puzzolana, than with hydraulic lime and sand.

On comparing the above mortars, left in the air, with the same mortars put in water, we are led to the following conclusions: when mortars are made of hydraulic lime and sand, to be used in masonry exposed to the air, it is of great importance to use the lime soon after it is burned: otherwise it loses a great portion of its force, as it does under water. When we are obliged to wait some days before using it, it should be slaked to dry powder, by throwing on a quarter of its volume of water, and be immediately covered with the quantity of sand that is proper to mix with it to make mortar. These kinds of lime should not be left to slake spontaneously, because they require a considerable time to become reduced to powder, and in general, lose a great part of their energy. Before deciding on adopting the process of air-slaking for hydraulic limes, we should previously convince ourselves by experiment, that the particular limes are exceptions to the general rule; that is to say, that they do not lose a great part of their energy by being left to slake in this manner. If the hydraulic lime we have at command has no great force, we may, nevertheless, make very good mortar by mixing sand, and a quantity of some substance analogous to puzzolana with the lime. For example, with calcined clay-dust of good quality, we may have a mortar of great hardness (even when the lime has very little hydraulic property, or is nothing but fat lime) by mixing lime, sand, and clay-dust, in equal parts: but a less proportion of clay-dust may suffice, with a greater degree of hydraulic strength in the lime, or if the work consist of gross masonry.

Comparing mortars made of the same constituents, and in the same manner —some having been left in the air, and others put under water, we see that the latter, in general, have given the greater resistances. Humidity is, therefore, favourable to hydraulic mortars. In the case of masonry made of fat lime, it has always been recommended, if earth was to be laid against it, that it should be left to dry for some time, before backing it with earth; and with the same object it has been directed to wait a year before pointing the work. We see that with hydraulic mortars used in the air, it will be better to act differently. As the masonry rises, it will be best to throw the earth against it. The pointing should be finished at the same time as the masonry, this being the better and more economical mode. During warm weather, the top of the wall should be copiously watered, at the

close of the day, and whenever the masons break off during the day. This was always done at Strasburg, and was found to be a good practice.

I shall give in the following table several experiments that I made with various kinds of lime, in order to know their quality and the quantity of sand that might be mixed with them.

Table No. XXXVI.

No. of the Mortars.	Composition of the mortars.	Weights supported before breaking.
		lbs.
1	Yellow Obernai lime slaked to powder and measured in powder . . . . . 1 Sand 2	3 196
2	Same lime . . . . . 1 Sand 2½	3½ 161
3	Same lime . . . . . 1 Sand 3	4 99
4	Yellow Obernai lime measured in paste . . 1 Sand 2	3 301
5	Same lime . . . . . 1 Sand 2½	3½ 275
6	Same lime . . . . . 1 Sand 3	4 242
7	Another Obernai lime measured in paste . 1 Sand 2	3 220
8	Same lime . . . . . 1 Sand 2¼	3¼ 165
9	Same lime . . . . . 1 Sand 2½	3½ 143
10	Same lime . . . . . 1 Sand 2¾	3¾ 88
11	Same lime . . . . . 1 Sand 3	4 66
12	Yellow lime of Bouxviller measured in paste . 1 Sand 2	3 231
13	Same lime . . . . . 1 Sand 2¼	3¼ 242
14	Same lime . . . . . 1 Sand 2½	3½ 253
15	Same lime . . . . . 1 Sand 2¾	3¾ 231
16	Same lime . . . . . 1 Sand 3	4 187
17	Oberbronn lime measured in paste . . 1 Sand 2	3 297
18	Same lime . . . . . 1 Sand 2½	3½ 165
19	Yellow Obernai lime alone—reduced to paste .	323

Observations on the Experiments of Table No. XXXVI.

The first three numbers were made of the yellow Obernai lime, slaked to powder soon after leaving the kiln. The proportions were one part of lime to the several quantities of sand stated in the table. We see that the strongest result corresponds with the least quantity of sand. Different circumstances having taught me that hydraulic lime would not bear as much sand as is commonly thought, I proportioned the following mortars with lime measured in paste.

Nos. 4, 5 and 6, were made at the works, and consequently with mixed

pieces of lime; the proportions are shown in the table. The best result answers to one of lime and two of sand, and it will be remarked that these three mortars are superior to the first three, which I attribute principally to a smaller quantity of sand.

The numbers from 7 to 11, were made of lime from another burning: the sand was augmented each succeeding trial by a quarter of the bulk of lime, while in the preceding experiments it had been augmented by a half. The best result corresponds with one part of lime in paste to two parts of sand; it is possible that a smaller proportion of sand would be still better, for we see that No. 19, which is lime reduced to paste without any sand, gave a stronger result; but as No. 19 was made of lime of another burning, I placed it at the end of the table that it might not lead to any false conclusions. I did not anticipate that there may be good hydraulic limes which will support only a very small quantity of sand; otherwise, I should have commenced the series with a much smaller proportion.

The numbers from 12 to 16, are mortars made of the hydraulic lime of Bouxviller, a small village situated at the foot of the Vosges, between Haguenau and Savern. This lime was treated in the same way as the Obernai lime that precedes it in the table. We see that the Bouxviller lime will bear more sand than that from Obernai, and that the best result corresponds to the proportion of one part lime measured in paste to two and a half parts of sand. The lime was of the same burning as that used in table No. III. Comparing the figures of the two tables, I was surprised to see that the same lime supported more sand in the air than in the water, which has happened very rarely in the course of my experiments; I am ignorant whether this is owing to some peculiar circumstance, or is a quality pertaining to certain hydraulic limes.

The experiments Nos. 17 and 18, were made with lime from Oberbronn, a village at the foot of the Vosges, to the left of the road from Haguenau to Bitche. I obtained a very good result with one part of this lime measured in paste and two parts of sand; but No. 18 shows that by putting two and a half parts of sand in the mortar, it lost nearly half its force. When making these two experiments with Oberbronn lime, I put, on one side, a fragment which I slaked with one-fifth of its volume of water, so as to reduce it to dry powder. I left it in this state, in the air, for fifteen days. I then made a mortar like No. 17. This mortar broke with the weight of 132 lbs., in lieu of the 297 lbs. which the mortar supported when made of lime just slaked. I obtained a similar result with the Bouxviller lime. All the limes, therefore, which I have used in my experiments in the air, and which are included in the preceding tables, require to be used a very short time after being burned: they lose, otherwise, a great portion of their energy; as is also the case when they are used in water.

No. 19 was made, as I have said, of Obernai lime, alone, reduced to paste with water. When I saw the hardness of this hydrate, my intention was to make similar trials with other limes, in order to know if the sand added in the composition of mortars, always, or only with some peculiar limes, diminished the resistance of the hydrates: but I was obliged to quit Strasburg before it was in my power to make the essays.

ARTICLE XIII.—*Various experiments with Mortars exposed to the Air.*

In this article I shall give several experiments which I made on mortars

exposed to the air. Several are repetitions of those contained in article VII, of mortars placed in water.

Table No. XXXVII.

Composition of the mortar.	Made immediately.	After 12 hours.	After 24 hours.	After 36 hours.	After 48 hours.	After 60 hours.	After 72 hours.	After 84 hours.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Obernai lime slaked to a moist powder, with a volume of water equal to the volume of lime . . . . . 1 } 3 Sand . . . . . 2 }	220	209	165	132	132	110	92	68

Observations on the experiments of Table No. XXXVII.

The above experiments were made with the same lime, and in the same proportions, as those of table No. XXVI, of which the mortars were put in water. For the manner of operating, I refer, therefore, to the observations on table No. XXVI.

These air mortars behaved like those placed in water. The mortar made immediately, afforded, in the air, a resistance rather less than the corresponding mortar of table No. XXVI; the others gave results about the same in the two cases. It is therefore important not to slake hydraulic lime with too much water, whether it is to be used in the air or in water; and we perceive that the method proposed by Mr. Lafaye is very inconvenient for hydraulic lime, because it requires the quick lime to be broken into small pieces of nearly equal size, which is a long and expensive operation. Unless this be done, the small pieces will absorb too much water, and the large pieces too little.

Table No. XXXVIII.

No. of the mortars.	Composition of the mortars.	Weights supported before breaking.
		lbs.
1	Mortar made of equal parts of common lime, sand and trass	143
2	Same mortar, worked anew, without water, after 12 hours	154
3	Same mortar, worked anew with a little additional water, after 12 hours	209
4	Same mortar, do. after 24 hours	198
5	Same mortar, do. after 36 hours	165
6	Same mortar, do. after 48 hours	187
7	Mortar of 1 part of Obernai lime and 2 parts of sand .	154
8	Same mortar, worked anew with a little additional water, after 12 hours	176

Observations on the experiments of Table No. XXXVIII.

These experiments were made with the same lime as, and in a similar manner to, those recorded in table No. XXVIII. The first six mortars correspond to Nos. 1, 3, 4, 6, 8, and 10, of that table, which were put under water. I made similar trials with lime and sand only; but, as I used lime which had been slaked for some time, I obtained only feeble results—the greater part of the mortars not supporting the weight of the scale pan.

If we compare No. 2 of the above table with No. 1, we see that the mor-

* This mortar was cracked, which may have lessened its resistance.—Author.

tar that was reworked without water, after twelve hours, gained but little upon that which had not been reworked; but that No. 3, which had been reworked with a little water, had gained a good deal. After twenty-four hours, the mortar No. 4 had become so dry that it was impossible to rework it without water; I was therefore obliged to moisten it a little, like No. 3. We see that the result was about the same as at the end of twelve hours. After thirty-six hours the hardness had become sensibly weaker, and at the end of forty-eight hours it had become stronger than at the end of thirty-six hours—an anomaly which I cannot explain.

Comparing the results of the above table with the corresponding ones of table No. XXVIII, we find that the resistances of the mortars left in the air are sensibly less than those placed in water. We see also that in both cases, I obtained no advantage of consequence, by reworking the mortars without additional water; but that there was a material augmentation of force, on reworking the mortars with a little water.

Nos. 7 and 8, of the above table, answer to Nos. 13 and 14 of table No. XXVIII, and were made of the same lime. There is in these mortars, also, much resemblance as to the effect of reworking upon mortars in air and in water; that is to say, the mortar which had been reworked with a little water after twelve hours, presented a greater resistance than that which had not. The resistances of these tables are generally rather weak, because of my using lime which had been slaked for about fifteen days.

At all works, it is often necessary to rework the mortars in the course of the day, especially in hot weather, when it dries very quickly and becomes too stiff to be used. During the hours of recess from labour, and when the works are interrupted by rain, the mortar will harden considerably. It would sometimes demand a great deal of labour to restore the mortar to a suitable consistency without water. My practice has always been to add a little water whenever the mortar had become, from any cause, too stiff, and required reworking. The preceding remarks show that no disadvantage attends this mode of operating. There is, no doubt, a limit, both as to the quantity of water to be added, and as to the time elapsed before reworking; and I purposed making other experiments in order to ascertain these limits, but I had not time. The experiments cited are nearly sufficient, and they prove that the opinion on which is founded the saying that "*mortar should be tempered with the sweat of the workmen,*" is a prejudice leading to considerable useless expense. The essential point is, that the lime, and the substances added to it, be intimately mixed; and this is most easily accomplished when the mortar is soft.

Table No. XXXIX.

No. of the mortars.	Composition of the mortars.	Weights supported before breaking.
		lbs.
1	Obernai lime slaked to powder, with 1-5 of its volume of water, leaving it in the air . . . . 1 } 3 Sand . . . . . 2 }	154
2	Same lime, slaked to powder with 1-5 of its volume of water, covering it with sand . . . . 1 } 3 Sand . . . . . 2 }	154
3	Same lime, slaked by plunging it into water for fifty seconds . . . . . 1 } 3 Sand . . . . . 2 }	132

Observations on the experiments of Table No. XXXIX.

These experiments are the repetition of those described in table No. XXV, and they were made of the same lime. The results are similar to those given by mortars put under water; only they are a little weaker. The comparison of Nos. 1 and 2 shows that there is no advantage, when slaking lime, to cover it with sand. This is called *stifling* the lime; and several constructors think that the vapour which rises, on slaking, possesses valuable properties.

Mortar No. 3 of table No. XXXIX was made of the same lime as No. 3 of table No. XXV, and I used, in slaking the lime, the process recommended by Mr. Lafaye, which consists in dipping the quick lime into water. The resistance was less than No. 1, which was slaked by throwing on a little water. This appears to me to be owing to the pieces of lime absorbing too much water from being in small pieces; and as the lime remained twelve hours in this state, it lost a part of its force—for it follows, from tables Nos. XXVI and XXVII, that lime, slaked to a humid powder has already lost a part of its energy, when it has lain twelve hours exposed to the air.

Table No. XL.

No. of the mortars	Composition of the mortar.			Weight supported before breaking.
				lbs.
1	Common lime measured in paste Pulverized bricks lightly burned	1 2½	3½	297
2	Same lime Pulverized bricks well burned	1 2½	3½	143
3	Same lime Pulverized tiles lightly burned	1 2½	3½	253
4	Same lime Pulverized tiles well burned	1 2½	3½	99
5	Same lime Pulverized tiles lightly burned—recalcined for six hours.	1 2½	3½	0

Observations on the experiments of Table No. XL.

The above experiments are of the same kind as those made with mortars put under water, and reported in table No. XVI. These air-mortars gave similar results with those put in water; that is to say, those made of pulverized bricks, or tiles, but lightly calcined, gave much better resistances than those made of more highly burned bricks or tiles. We see that the dust of No. 5, which had been recalcined by being kept red hot for six hours, gave with the same lime, a mortar that had no strength. The dusts used in these trials, like those of table No. XVI, contained a notable quantity of lime. The resistances of the mortars left in the air, were, in this instance also, rather less than those of the mortars put in water.

Table No. XLI.

No. of the mortar.	Composition of the mortar.			Weight supported before breaking.
				lbs.
1	Common lime measured in paste Brick dust	1 2½	3½	132
2	Same lime Brick dust, same as No. 1, recalcined for half an hour	1 2½	3½	165
3	Same lime Brick dust same as No. 1, recalcined for one hour	1 2½	3½	275
4	Same lime Brick dust, same as No. 1, recalcined for two hours	1 2½	3½	308

Observations on the experiments of Table No. XLI.

These experiments correspond with those of table No. XVII, that is to say, having used brick dusts which gave resistances the feebler the more they were burned, as those of tables Nos. XVI and XL.—other brick-dusts were found, as those of tables Nos. XVII and XLI, which gave results exactly opposite. The mortars of the two tables XVII and XLI, gave in air and in water, results so much the stronger as the cements had been the more burned. In speaking of tables Nos. XVI and XVII, I said, that the differences were owing to the cements of table No. XVI, containing much lime, while those of table No. XVII, contained little. But the cements of tables Nos. XL and XLI, were the same as those of tables Nos. XVI and XVII, and the results in the air were just like those in the water. The comparison of these four tables leads to an important conclusion; namely, that clay-dusts which give results with fat lime, when placed under water, will also give good results, when exposed to the air: and if the results be bad in the first case, they will be equally so in the second. Whence it follows that to know whether clay dust which is to be used in air mortar, will give good results it should be tried with fat lime in water; following the process pointed out in the first section. We may be certain that cements which have not the property of causing fat lime to harden in water, will give, in the air, no better results than the same lime mixed up with sand alone. On the other hand, the more hydraulic the cements are, the better, for all uses in the air. The trials of which we have spoken, should not be neglected, for they are of great importance, as regards the solidity of masonry exposed to the air.

Table No. XLII.

No. of the series.	Composition of the mortars.	Weight supported before breaking.
		lbs.
1	Obernai lime alone, reduced to paste	323
2	Verdt lime alone, reduced to paste	99
3	Metz lime alone reduced to paste	119
4	Lime from the Boulogne pebbles	99
5	Mortar composed of one part of fat lime that had been long lying slaked and wet, measured in paste—and two parts of puzzolana	429
6	Mortar made of one part of same lime do. and two parts of trass	451
7	Mortar do. do. do. and two parts of Sufflenheim cement	429
8	Mortar do. do. do. one of sand and one of Sufflenheim cement	363
9	Mortar do. do. do. and two pars of forge scoriæ	55
10	Mortar do. do. do. one of sand and one of Paris cement	0
11	Mortar made of one part of fresh lime measured in paste and two parts of common sand	77
12	Mortar do. do. do. and two parts of common sand pulverized	121
13	Mortar made of one part of Obernai lime measured in paste and two and a half parts of common sand	187
14	Mortar of one part of same lime do. and two and a half of sand, pulverized	275*
15	Mortar of one part of quick-lime but little burned, measured in paste, and two parts of sand	—22
16	Mortar made of one part of Lixen lime measured in paste and two parts of earthy sand	—22
17	Mortar of one part of same lime do. and two parts of River sand	143
18	Mortar of one part of do. do. and two parts of earthy sand, washed	176
19	Mortar of one part of Dosenheim lime and two parts of earthy sand	—22
20	Mortar of one part of same lime and two parts of river sand	132
21	Mortar of one part of do. and two parts of earthy sand washed	176

Observations on the experiments of Table No. XLII.

This table contains a variety of experiments, which I will explain. Nos. 1, 2, 3 and 4 were made of lime slaked soon after being burned, and by the necessary quantity of water, reduced at once to paste. These hydrates of lime like the mortars which precede them, were placed in a cellar, and tested at the end of a year. The hydrate of Obernai lime, No. 1, was very good. No. 2, a hydrate of Verdt lime, gave so feeble a result as to surprise me, after that which I had obtained by placing a hydrate of the same lime in water—table No. III shows that the resistance of this hydrate was 484 lbs. As the specimens were from different burnings, I presume that in this last trial, I used a piece but feebly hydraulic. The Metz lime

*This mortar being a little cracked, its resistance was diminished.

No. 3, gave a feeble result, also. I have already said that I made but few experiments with this lime, and it is possible that the small quantity that was sent me was, by accident, but feebly hydraulic. No. 4 was from the Boulogne pebbles, and was treated the same way as the preceding. The resistance was feeble, and, we have seen (table No. VIII) that, with a single exception of a trial made with this lime highly calcined, all the mortars it has furnished, have supported but small weights. The above lime, No. 4, had received only the ordinary calcination.

Nos. 5, 6, 7, 8, 9 and 10 were made of fat lime that had been lying slaked, and wet, for five years, since the erection of the Theatre. The proportions were one part of this lime in paste, to two parts of the several substances mentioned in the table. The mortar No. 5, composed of this lime and puzzolana, gave a very good result. No. 6 made, in the same manner, of trass, gave a resistance a little better still. Mortar No. 7 made of the hydraulic cement of Sufflenheim, gave a resistance equal to that afforded by puzzolana. Mortar No. 8 made of equal parts of lime, sand and Sufflenheim cement, supported a weight rather less than No. 7, in which there was no sand. No. 9 was made in the same manner as the preceding mortars, using the scoria of forges. I satisfied myself that these scoria contained little or no clay; and it is to this that I attribute the bad result. I said in the first section, that with the Tournay ashes, and the ashes of the forges of Boulogne, very good mortars were made; owing to this, that the sea-coal, burned in the forges of those places, contained a considerable quantity of clay, which was calcined in a current of air, by the combustion of the carbon of the coal. The scoria of forges, and the ashes of furnaces, should not, therefore, be used in mortars in the air, before ascertaining whether these matters have the property of causing lime to indurate under water.

No. 10 is a mortar composed of one part of fat lime measured in paste, one part of sand, and one of Paris cement. This cement was from the manufactory of Mr. Saint Leger, and was the same as that used for the mortars put into water. We saw, at page 22, that two mortars made of this cement had promptly hardened in water, but that both were cracked. The mortar made of one part lime and two parts of cement supported 187 lbs., and that made of lime, sand and cement, supported only 99 lbs. I was much surprised at the bad result of the mortar No. 10 in table No. XLII; it had so little consistence that it crumbled easily between the fingers. I attribute the bad effect to the great quantity of lime that Mr. Saint Leger mixed with the clay, in making the cement. It might be that the cement was too much burned. Some separate trials lead me to think that cements made of clays containing about one tenth of lime, are less proper for mortars in the air than for mortars in water: it appears also that they allow but little sand in the composition of the mortar. I intended making some experiments to settle this matter but had not time. My departure from Strasburg also prevented my making, with the several clays of the environs of that place, experiments in the air, analogous to those which I made with the clays, under water. My various essays, however, induced me to think that in making artificial puzzolanas for mortars intended to be exposed to the air, the presence of lime in the clays to be calcined, is still more hurtful than when the mortars are to be used under water. Clay, therefore, should be chosen which contains no lime or very little.

Nos. 11 and 12 were made of fat lime reduced to paste shortly after burning. No. 11 was made of one part of this lime measured in paste, and two parts of common sand. No. 12 differs only in having the sand pulverized. We see that the result was much better with the fine sand. Nos. 13 and 14 were similar experiments made of Obernai lime. With the fine sand, the resistance was, in this case also, much the greatest, although the mortar was so cracked as necessarily to diminish its force. We have seen in table No. XXIX, that mortars in water gave similar results. We ought to conclude, therefore, that whether for mortars in air or in water, fine sand is the best, notwithstanding the opinion to the contrary of most constructors.

Old mortars are often found which are very hard, and which contain a great quantity of gravel as large as a pea. This fact is sometimes cited to prove that it is best to use coarse sand in gross masonry, but the reasoning is not just. These kinds of mortars are really concretes: the gravel they contain can have no influence on the goodness of the mortar. But if this gravel is mixed with fine sand (as is often the case) and the lime is hydraulic, then a very good mortar is obtained—the strength of the mortar depending on the strength of the lime.

No. 15 was made of lime which had been placed above the tiles in the kiln, and was, therefore, but slightly burnt: it was the same lime as was used in making the mortar to be put in water, No. 8 of table No. XXIX. Only bad mortars were obtained by this means, either in the air or in water.

Nos. 16, 17 and 18 were made of three different kinds of sand and a lime moderately hydraulic, obtained from the village of Lixen, near Phalsburg. No. 16 was made of one part of this lime, measured in paste, and two parts of a very earthy pit sand, which is found in the neighbourhood. The resulting mortar had so little consistency, that it could not bear the weight of the scale pan. No. 17 was mixed in the same proportions with river sand from Zorn, near Saverne; the resistance was passable. The same proportions were observed, in mixing No. 18, with the same sand as was used in No. 16, after being freed, by washing, from earthy matter. We see that this mortar was good, and superior to the mortar made of river sand.

Nos. 19, 20 and 21 were repetitions of three preceding experiments: using, however, another lime, also moderately hydraulic, obtained from the village of Dosenheim. The mortars made of Dosenheim lime, like those made of Lixen lime, prove that earthy sands afford only very bad mortars; but that, being washed, they are superior to river sands. I was led, in 1823, to make these experiments, because there was to be had near Phalsburg only pit sand which was half earth. Whenever there was any work to be executed requiring some care, the people of that place were obliged to get river sand from the river Zorn on the other sides of the Vosges. This brought the price to about $0.05\frac{1}{2}$ per cubic foot—so high as to prevent its being procured for the masonry of revetments: it resulted that the masonry of that place, made of mortar in which the earthy sand of the neighbourhood was used, has needed considerable repairs, and in making the necessary reconstructions, it was very apparent that the degradations had been owing to the bad quality of the mortar.

After getting the results of these last experiments, I used no sand at Phalsburg except washed pit sand. It required 70.68 cubic feet of the earthy sand to yield 35.34 cubic feet of the washed sand: 0.62 of a day's

work sufficed for the washing: it would, therefore cost less than one half of the expense of bringing the river sand.

The sand may be washed on a large scale in the following manner; a basin being made of masonry from seven to ten feet wide, and from twelve to sixteen long, the height of the walls should be about two and a half feet, with the exception of one end, which should be only one foot two inches high; the bottom should be paved with flat stones; the basin should be built near a stream of water, or if that be not practicable, a well should be sunk near it. A layer of sand of about one foot thick, should be placed in the basin, and a plank one foot four inches wide placed on edge, on the low wall, raising it to the height of the other walls—the plank being fitted into grooves made in the side walls to receive it. The basin must then be filled with water from a brook, or from a pump in a well, as the case may be; and the sand must be well stirred up with *rabs* by two or three labourers. Allowing the time found to be necessary for the sand to precipitate, the plank must be suddenly withdrawn, and a great part of the water will pass off at once, loaded with earthy matter. This operation must be repeated until the water passes off but slightly turbid: the sand may then be taken out and left to dry, and the washing be applied to another portion.

For economy, the basin may be constructed of planks, as was done at Phalsburg. It was six feet eight inches long, four feet four inches broad, and two feet two inches deep. There was left in front an opening of only fourteen inches deep by ten inches broad. But this opening was too small for the water to run off rapidly. It is best to place a movable plank of some breadth across the whole front of the basin, so that the water may pass off very quickly.

The last experiments of table No. XLII, show how important it is to use clean sands in making mortars: but before washing off the earthy matter, it is proper to be satisfied, by the means I have pointed out, that the sands are not arenes.

Article xiv.—*Observations on Mortars exposed to the Air.*

It results from the experiments given in articles XI, XII, and XIII, that in exposing to the air mortars made of sand, and lime which had been laying a long time slaked and wet, I obtained no satisfactory result; while I obtained tolerable results with sand, and the same lime recently slaked. The resistances of these last mortars were 68, 77, and 99 lbs., while the others were unable to support the scale pan, whatever may have been the process of fabrication. I ought not, however, from this to take up a general conclusion, and counsel against slaking and running lime into vats to preserve it; because I have not made experiments enough to pronounce positively on the subject—which is one of great importance. It is necessary to repeat these trials in different countries, so as to operate on various kinds of lime, before proscribing this method; which, while it may be a bad method for certain kinds of lime, may be very good for other kinds. I do not know for how long a time the method of running lime into vats has been followed. It may have been introduced in consequence of the considerable increase of bulk which it gives. I do not know that it was followed by the ancients. Vitruvius has left a work on architecture, in which he has given many details as to the manner the Romans carried on their works. We find in this author, as rendered from the Latin by Perrault, the architect, the follow-

ing passage extracted from Book II, chapter V: "When the lime has been slaked, it must be mixed with sand, in such proportions that there shall be three parts of pit sand, or two parts of river sand to one of lime: because this is the most just proportion of the mixture, which will be much better still, if there be added to the sea or river sand a third part of sifted tile dust."

We see nothing in this passage that indicates the mode of slaking; but it is certain that the Romans made great use of hydraulic lime, as there are many remains of their works in countries where this lime abounds: such are the constructions they have left us on the banks of the Moselle, and in several parts of France. But these limes could not be slaked and left in the above manner, (as they would harden in the water;) and, if it had been the practice to slake them differently from fat lime, Vitruvius would no doubt have mentioned it. It appears probable to me, therefore, that the Romans used fat lime as they did hydraulic lime, that is to say, immediately after the burning. This is the more likely, as Vitruvius directs, in the process of stucco making, that only lime that had been long slaked should be used. The following are his remarks on this subject. Book VII, chapter II. "Having examined all that appertains to pavements, the manner of making stucco must be explained. The principal matter in this is, that the lime should be slaked for a long time, so that if there should be some particles less burned than the rest, they may, having time thus given them, be as thoroughly slaked, and as easily tempered, as that which was thoroughly calcined: for, in lime which is used as it comes from the kiln, and before it is sufficiently slaked, there is a quantity of minute stones imperfectly burned, which act on the plaster like blisters. because these particles slaking more slowly than the rest of the lime, break the plaster and mar all the polish." It appears to me that the precaution of slaking the lime a long time before hand, is here recommended as an exception, and that in the mortars intended for masonry, the Romans used all limes soon after they left the kiln. It is remarkable that the same author directs, in the first passage cited, mixing with the mortar a portion of sifted tile dust, observing that it will much improve the mortar.

We have seen that my experiments were very unfavorable to the process indicated by Mr. Loriot and Mr. Lafaye: they were in error in recommending them as, in principle, recovered from the Romans. Moreover, these processes have, for a long time, justly fallen into disrepute.

As to the opinion that the hardness of mortar is due to the regeneration of carbonic acid, I have shown that according to the analysis of Mr. Darcet and Dr. John, several ancient mortars, although very hard, contained but a small portion of the carbonic acid necessary to the saturation of the lime. It has been stated that the Italians sell little caskets and snuff boxes which they make of ancient Roman mortars: but it has been noticed that they use for these purposes only the exterior parts of the mortar in which the lime had passed to the state of carbonate, while the interior often afforded but a weak consistence.

In examining Roman mortars, it is observed that they are often of great hardness, although it is evident that the mixture had been made with very little care. We must therefore attribute the hardness of these ancient mortars to other causes; for, as I have said, all these mortars are not by many degrees equally hard.

To explain the hardness of Roman mortars, it will suffice, I think, to cast the eyes over tables Nos. XXXVI, XL, XLI, and XLII. Table No. XXXVI contains mortars made of hydraulic lime and sand. These mortars

exposed to the air for one year only, show great tenacity. Tables Nos. XL, XLI, and XLII, contain, also, very good mortars made of fat lime, puzzolana, trass, and several kinds of cement. The use of cement goes back to high antiquity, for Roman and Egyptian structures often contain it. Those who wish to solve this question, without recourse to the quality of the lime, or to cements, object that there are ancient remains which appear to have been made of fat lime, since they are seen in countries where no puzzolana or hydraulic limes are to be found, and they have not the aspect of mortars made with cements. I will observe, touching this point, that if we examine the two tables in pages 87, which contain the analyses of several lime stones, we shall see that many limes which are ranked with fat limes contain, nevertheless, small quantities of clay. Although they may not contain enough clay to harden under water, they ought to afford much better mortars in the air than those limes which contain none. Again, hydraulic limestones are often found disseminated amongst the strata of fat lime stones. And, lastly, the important observation of Mr. Girard, on the hydraulic proportions of *arenes* explains easily how very good mortars may have been made of fat lime. I will observe, in addition, that the Romans, in all the countries they occupied, executed a great many works, of which only those made of good mortars survive to the present day. Saint Augustine complains of the manner in which mortars were made in his day: and the same complaints are found in Pliny; who says, chapter XXII, "that which causes the ruin of the greater part of the edifices of this city (Rome) is, that the workmen employ, from fraud, in the construction of the walls, lime which has lost its quality."* We see, therefore, that all the Roman mortars were not good.

For my part, I am convinced, that if those ancient constructions that have reached our times, be examined with attention, it will be ascertained that they were made either with hydraulic lime and sand, or with fat lime and sand mixed with cement, or with arenes: in a word, that these mortars had all the elements of good hydraulic mortars.

We are in the habit of composing our mortars of fat lime and sand; the preceding experiments show that we are wrong: our mortars have, consequently, little durability. We shall not obtain durable masonry in the air, until we make use, therein, of hydraulic mortars. In countries where good natural hydraulic lime is to be had, no other kind should be used for any purpose whatever. For ordinary masonry, the mortar should, in that case, be made of lime and sand only. In countries where there are no natural hydraulic limes, but where there are arenes, the mortar should be made of fat lime and these arenes: in both these cases the mortars would be cheap. In countries where neither arenes nor hydraulic limes are to be procured, it will be necessary to incur a little additional expense, and make use of fat lime, sand, and hydraulic cement. To combine economy and solidity at the same time as much as possible, the proportions, in cases where there are to be one part of fat lime and two of sand and cement, the mixture may be made as follows, viz: one part of fat lime measured in paste, one and a half of sand, and a half of hydraulic cement; (according to similar proportions made with trass, as shown in table No. XXVII,) we should have, by this means a very good mortar. The proportions of hydraulic cement, stated above, should be used in all common masonry: in works demanding more care, the mortar should be composed of lime, sand, and cement, in equal

*We might infer, from this passage, that Pliny complained because the lime was not used soon after its calcination. AUTHOR.

parts. I have said, that the proportions indicated for common masonry, should augment the expense but little: but were the augmentation more considerable, it is certainly much more economical to incur at once, all the expense necessary to produce a permanent work, than to build at a cost rather less in the first instance, and to be obliged to reconstruct the work entirely, after no great lapse of time. A government should construct for posterity: and I do not doubt that this end would be attained by making all masonry with hydraulic mortar, in the manner I have pointed out.

Officers of engineers often have to construct arched rooms, passages, &c., that are to be always covered with earth. The mortar of these constructions is generally composed of fat lime and sand. To resist filtration and humidity, it is customary to place a cap, or masonry roof, made of hydraulic mortar, over these arches: but experience shows that these caps do not fulfill their object, and that they often afford a passage to the water, especially when made of bad cements. I cited an example at page 23, and I might cite many others. Even when the caps are made of good mortar, it may happen that there is humidity in the casemates, and that the arches leak: for we have seen at page 160 that mortars made of fat lime do not dry completely, even in a century, when the walls are thick. And this result is the more certain when the masonry is covered with earth as in casemates. The walls against which the earth lies, almost always allow the water to transude, although the cap may be impermeable. Besides, from the considerable load that these arches often sustain, the masonry that has been made of mortar slow to harden, will settle, causing cracks and leaks in the caps. The only means of obviating these disadvantages, is to construct all the masonry of the casemates with hydraulic mortar. We shall thus secure the great advantage of a prompt induration: the subsidence will consequently be less sensible, and cracks less apt to occur; the walls will no longer allow moisture to transude, and even should there be some cracks in the caps, the water will, with difficulty, find its way through arches made with hydraulic mortar.

The manipulation of mortars designed for exposure in the air, should be the same as that described in the first section for mortars designed for water.

Article xv.—*On factitious Stones and Concretes, exposed to the Air.*

Mr. Fleuret, formerly Professor of Architecture in the Royal Military School, of whom I have before had occasion to speak, published in 1807, a work on the art of composing factitious stones. The following passages are to be found in page 12: "The art of building with factitious stones is very old; it was in use with the Babylonians, and the early Egyptians, amongst the Greeks and Romans, and it is still pursued in Barbary, and amongst the nations of Malabar.

"According to Pliny, the columns which adorn the peristyle of the Egyptian labyrinth, were of artificial stones, and this vast edifice has existed three thousand six hundred years. The pyramid of Nynus is formed of a single block. The enormous stones composing the great and strong walls raised in the empire of Morocco, as is reported by the Abbe de Marsi, from writers whom he quotes; the square stone that formed the tomb of Porsenna, spoken of by Varro and Pliny, which was thirty feet wide by five feet high, were composed in the same manner as the pyramid of Nynus, and lead us to believe that these monuments owe their existence

and their preservation to a process as easy as it is simple, and which unites the advantage of solidity with economy.

"All factitious stones of a volume thus considerable, were made by encasement, and the process of massivation; that is to say, that in the great walls built thereof, these stones were formed the one upon the other, by beating the materials, with rammers, into spaces formed by planks, as I shall explain."

Mr. Rondelet states, in his preface, that the columns of the choir of the church of Véselay, in Bourgogne, were ascertained to be factitious stones by Marshal Vauban, and the pillars of the church of Saint Amand, in Flanders, were made in the same manner.

I have had no opportunity to ascertain whether blocks of stone of extraordinary dimensions, were factitious; this question could not be well settled, except by examination of the masses themselves. It is possible that several of the large blocks mentioned were factitious: but it is not easy to believe, in a wall formed of large pieces placed one upon another, that these large pieces are factitious, for it seems to me that it would be much more difficult to construct a wall of that sort, than to make the whole wall of one piece, whereby the moving and transportation of masses of an enormous weight would be avoided. I do not at all doubt that artificial stones of large dimensions may be made, for all depends on making a good mortar: nevertheless it seems proper not to admit such facts as are cited above without a thorough examination.

The Italians, at Alexandria, make very good factitious stones with the Casal lime, and employ them in angles; they are four feet eight inches long, by two feet eight inches wide, and two feet eight inches high; they are buried under ground for two or three years, and there acquire great hardness. These stones are made in the following manner. For one cubic yard they take 0.24 of Casal lime measured in paste, and 0.90 of sand. These are well mixed together, adding the water necessary to form a paste, and there is then added 0.20 of pebbles, *(cailloux;)* these factitious stones are therefore real concretes. Their goodness depends on the quality of the mortar applied to making them. Mr. Fleuret proposes to make the mortar for these factitious stones in the following manner.

He slakes the lime by immersion, according to the process of Mr. Lafaye, to which he attaches great efficacy. When slaked to dry powder, it is to be deposited in a dry situation, enclosed in casks covered with straw mats loaded with stones. He recommends that, each time the cask is resorted to for lime, a part only of the mat should be raised, and that it be replaced as soon as possible, in order to guard gainst the contact of the air, which he says is very hurtful. He makes a perfect mixture of sand and clay dust, in the proportion of two measures of sand to one of dust; or, which is better, he mixes sand and dust in equal parts. He then takes two measures of the mixture of sand and dust, and one measure of lime after being tempered with water, and makes them into a heap. He then works them dry, moistening them little by little as they mingle. Lastly, they are taken to a trough, where they are beaten by rammers of wood armed with iron, which are suspended from the ends of poles acting with a spring, like the spring pole of a turner's lathe. Mr. Fleuret says the mortar is improved by wetting it in the trough with a little lime slaked thin, and used in the proportion of one-sixth of the mortar. He censures the practice of reworking the mortar with fresh portions of water, which he says weakens it much.

The author adds that hard stone pulverized, may be substituted for sand,

and that scoriæ, iron scales, and sea coal ashes, furnished by forges, are still better than pulverized stones and clay dust. These are, in brief, the means pointed out by M. Fleuret, for making the mortar he designs for factitious stones. The mortars being made after this process, they are placed in moulds where they are beaten and strongly compressed. Mr. Fleuret has made much use of factitious stone in making water conduits, pump tubes, troughs, &c.

Mr. Fleuret established a manufactory of factitious stones at Pont-a-Mousson. We might suppose that, having at his command the good hydraulic lime of Metz, he would obtain good results; but, as I have said, in the first section, when we attempted to apply this process to making factitious conduits at Phalsburg, and caps of arches at Landau and Strasburg—using the lime of the country, we did not succeed. What I have before stated shows that it is less the manipulation than the choice of materials which affords good mortar, and consequently good factitious stones. But Mr. Fleuret has not given us the means of ascertaining the quality of the materials: and it follows that in pursuing the path he has pointed out, we are exposed to bad results, as happened in the above cases.

According to the experiments I have made, the best process for making mortars to be used in forming factitious stones is, if we use hydraulic lime, to slake it to powder with about one quarter of its volume of water, and to cover it with the materials that are to be mixed with it. I have several times remarked on the importance of making the mortar soon after the slaking of the lime. We ought not therefore to slake more lime at one time, than will suffice for eight or ten days. If the lime be eminently hydraulic, sand only need be added; and, of sand, that which is fine should be much preferred. If only a mixed sand can be had, it should be passed through a fine sieve; if it be too coarse, it should be pulverized; and if it be earthy, it should be washed by the process I have given.

If the lime be only moderately hydraulic, it will be necessary to make the mortars by adding to the lime equal parts of clean fine sand and cement.

If we happen to be in a country where the only lime is fat lime, we have seen, by table No. XXXIII, that it is quite immaterial whether this lime be used as soon as it is burned, or after having been slaked for some time, to paste or powder. Care should be taken to use only hydraulic lime made of clay, which contained but little lime. The mortar will be made by mixing the lime with the quantities of clean fine sand and hydraulic cement which shall have been found by trial to be the proportion best suited to the lime. In general, the proportion of one part of fat lime measured in paste, to two, or two and a half, of the other ingredients, will afford a very good mortar. There will be no disadvantage in wetting the mortar sufficiently to cause it to work easily, nor in reworking the mortar with a little additional water, should it become too dry. An excess of trituration is useless; it is sufficient if all the materials be well mixed. All my experiments show that iron does not improve mortar. The scoriæ, and the ashes of forges should not therefore be used without our being satisfied before hand, by the means I have pointed out, that they are hydraulic.

When the hydraulic mortar of which the stones are to be formed, has been made as above, it should be placed in moulds, if the stones are to be of small dimensions, and should be loaded with weights, or submitted to heavy pressure, until it has acquired sufficient consistence to be withdrawn from the moulds without breaking. The stones are then to be deposited in a moist place for about one year.

When factitious stones are made for water conduits, or other objects that are to be buried under ground, there is no objection to using red cements, such as are generally made from brick earths; but this colour would be disagreeable to the eye; and in case the objects are to be exposed to view, cements derived from clays that do not take this colour from burning should be used; such, for example, as are used in making tobacco pipes, stone ware and crockery. With the same view, cement derived from slate may be used.

There is no doubt in my mind that with good mortar, factitious stones may be made which will afford, at the end of a year, a resistance approaching that of ordinary bricks, and that the strength will go on increasing with time. We find in the Annales de Chimie, Vol. XXXVII, that "Mr. Monge, in visiting the ruins of Cesaria, remarked, in a temple consecrated to Augustus, that the pillars had wasted away to a great depth, but that the mortar projected. He tried in vain to break off a piece. The mortar was of very fine and equal grain; it appeared to be composed of fine sand and very little lime, very well mixed." It has been remarked that in the ancient Roman constructions which still exist in the Northern districts, the mortar has perfectly resisted the inclemencies of the seasons. I made at Strasburg large cubes of hydraulic mortar, which I withdrew from the water after about one year, and left exposed to the air during several summers and winters without their sustaining any injury. In the 7th No. of the *Memorial de l'Officier du Genie*, it may be seen that I proposed in 1819, to cover with factitious stone the floor of a sluice *de chasse*, which was 100 feet wide and was composed of five passages. The foundation was of concrete, and it was covered with a layer eight inches thick of good hydraulic mortar, which became united to the concrete, formed a factitious stone, showing, the next year, great solidity. It has now been made ten years, and it has sustained no injury. This means may be used with great advantage in countries where there is no good stone for cutting, or where such stone is dear.

In countries where free stone is not to be obtained, it is very advantageous to be able to compose factitious stones to form the angles, copings, casements of doors and windows, cornices, gutters, water conduits, &c.; this mode of fabrication might even be applied advantageously to objects of the largest dimensions. It often happens that for bridges across the ditches of fortifications, pieces are needed of about three feet in thickness: where stones are not to be had of suitable quality, these pieces may be easily made on the spot in a single piece of factitious stone: under similar circumstances, piers of sluices, columns, and obelisks may, also, be made; but in the cases of such large masses, it will not be easy to bury them in the first instance, and afterwards place them in the proper situations. It will be best, therefore, to construct them on the spot. It does not seem to me to be indispensable to make plank moulds to give them their proper shape: forms such as are used to direct the construction of walls, would suffice. It would only be necessary to take care, when the mortar had been made of ordinary consistency, that it should stiffen a little before being used, so that on being spread with the trowel it would retain the form given it, and at the same time be so ductile as to spread easily and unite itself well with the previous layer. As this mortar dries very quickly, there is no danger that the work of the morning will give way under the pressure of that of the afternoon. After having finished the day's work, care should be taken to cover the top of the wall with wet straw matting, so as to maintain a favourable humidity; in the morning the surface of the mortar should be rammed with a small flat

rammer, and be made slightly wet, so as to be somewhat softened and brought into proper state to unite with the succeeding layer. As the work rises, care must be taken to surround it with straw, or some similar substance, which must be kept always moist during the first summer. If the work have but little altitude, earth may be banked against it. In all constructions of this kind, it is proper to make the work with a little excess of dimensions, so that the following year some tenth of an inch of the outside, which, having dried too quickly, will be less hard than the interior, may be cut away; pressure should always be applied, in any way most convenient, where the nature of the structure will permit it.

If it be thought proper, these factitious stones may be coloured at the time they are made, by mixing in the mortar composing the surface, some suitable metallic oxide.

If the factitious stones are to be of large dimensions, gravel or small stones may then, for the sake of economy, be mixed with the mortar: in such cases the resulting mass will be concrete. This substance was used by the Romans: several of their works are found in which the faces of the walls are of stones, and all the interior of a mixture of mortar and pebbles. Mr. Fleuret having enumerated, as stated in the beginning of this chapter, the great monuments supposed to have been made of factitious stones, says "There are even great walls constituting the enclosure of towns, large aqueducts, and piers of bridges, still remaining, nearly entire, from the time of the Romans, of which the faces are made of very small stones, and the heart of the wall of pebbles mixed with stones larger or smaller, thrown at hazard between these light facings. This masonry made of fragments, and rammed in an encasement, becomes but a single mass, and is rendered so compact by continuity, that in a short time the walls becomes indestructible."

I do not think that this masonry was made in encasements; the facing walls were substitutes therefor; and had there been no facings, the concrete, as I have before observed, might have been built up without moulds. But we see by the quotation, that the Romans made much use, in constructions in the air, of small materials mixed with their mortar, and it is this kind of construction which, as I have said, we now call concrete. I have stated, in the first section, that in repairing, in 1816, one of the dams which sustained the navigable canal of Strasburg in its passage across the ditches of the fortification, I found that the facings alone were of free stone, and that all the interior was of concrete, of great hardness, which led me to presume it had been made of hydraulic lime, and induced me to make researches, whereby I became possessed of the qualities of Obernai lime, and afterward of many other hydraulic limes in the neighbourhood.

In constructing with concrete the interior of baterdeau that have sufficient thickness, we may be certain of their great durability. In rubble or regular masonry, the mortar does not always unite itself perfectly to the stone—so that if there be a head of water, it will at least find a passage between the joints. This cannot happen in masonry made of small materials, as concrete, because all these small stones are separated from each other by a portion of the mortar which will oppose filtration. In the two baterdeaux of Strasburg which I have cited, the facings were displaced; but the central mass of concrete prevented a single drop of water from passing, notwithstanding the bad condition of the facings.

Mr. Rondelet says at page 116 of his work "There is found near Metz in France, a very hard stone with which they make lime of very superior quality; this lime, newly slaked and mixed with gravel, affords a concrete

or species of mortar, of which the consistence is so great that arches may be constructed of it, without bricks or stones; these arches form a single piece as hard as stone.

Lieut. Col. Finot has constructed at Strasburg, within two years, an arch of concrete of about thirteen feet four inches diameter, which has succeeded well: the piers are of masonry. A similar arch has been constructed at Schelestadt. This kind of arch offers great advantage in many circumstances.

When the arches are to be underground; this will be the best means of preventing filtration; but that the underground room may be perfectly dry it will be necessary to make the piers and end walls also of concrete.

It often happens that there are casemates and cellars which in time of floods, fill with water. This may be prevented by putting a structure of concrete upon the bottom: and if the water filters through the walls, by reinforcing them with a plaster of concrete. By these means we turned to profit, at Strasburg, several casemates, of which the floor was below the level of the water in the river, and in the ditches, in time of floods.

We are frequently obliged to carry a canal over a stream of water, and vice versa. In such cases aqueducts are built. It is here particularly, as in aqueducts in general, that concrete is indispensable. If it be thought proper to build the arches of stones or bricks, it is indispensable, in order to resist filtration, to make all the masonry above the arches, of concrete. In countries where proper materials for making the arches cannot be obtained at a reasonable rate, it will be advantageous to make the arches of concrete, in which case the aqueduct will be formed of a single piece. Arches of large dimensions may be constructed in this way, either for aqueducts or for ordinary bridges.

It is necessary sometimes to enlarge a wharf, in cases where the river cannot be restricted; and it is done by making all the courses of masonry, projecting, or corbel, courses—a very expensive construction, on account of the large dimensions which the stones must have. The same result may be obtained with concrete, which will form but a single piece of great solidity, at small comparative cost. By similar means *machicoulis*, which are sometimes necessary to protect the entrance to forts, may be made.

Researches are now being made as to the means of preserving grain in *Silos*. It is requisite to success, that the grain be preserved from the contact of the air, and from humidity. Both these conditions will be secured at the same time, by making the *Silos* of concrete. After the grain is deposited therein, it may be hermetically sealed by closing the mouth with the same substance. *Silos* may be of great advantage in provisioning fortified places: and it is important that attention be directed towards them.

In some departments in the north of France, no good building stones are to be found, and revetment walls are there constructed of fragments of chalk, there being a facing of bricks to preserve the chalk from contact of the air. But in several of these places the bricks are of bad quality, and this facing scales off, requiring considerable, and perpetual, outlays for repairs. In such circumstances it should be, I think, advantageous and economical, to build the revetment entirely of concrete. It should be composed of hydraulic mortar in which would be mixed gravel, fragments of chalk, bricks or any similar matters, in the proportions indicated in the first section. Taking care to apply on the outside a thick plaster of the same kind of mortar. The plaster should be applied at the time the con-

crete is laid, so that it may unite with it perfectly. By this means the chalk will be preserved from contact of air. As the wall rises, humid earth should be placed against the back of it, and the front should be covered with straw-mats or a thick layer of straw, which should be kept wet during all the first summer. In countries where good *arenes* are to be had, revetments in concrete would not be dear; and, besides the advantage of avoiding considerable expense in repairs, it would be more difficult to make breaches in revetments of concrete than in those constructed of stone.

I will observe that in the construction of revetments, which have, commonly, about thirty-three feet in height, and sustain a great mass of earth, the bad quality of the mortar often makes a much greater thickness of masonry necessary than if the mortar were good. By making, as I have proposed, all the masonry of hydraulic mortar, the expense will be augmented a little; but on the other hand it will be possible to diminish the thickness of the walls, which will be a compensation. By making the revetments of concrete they will be of a single piece, and the thickness may be sensibly reduced; which will amount to a great saving wherever good arenes are at hand. Nothing would prevent these revetments being made with counterforts or with relieving arches.

In the south of France particularly, are to be seen revetments of great exterior slope. This mode of construction, permits the thickness of masonry to be considerably reduced: but it cannot be adopted in the north, because of the humidity which favours the development of vegetation in the joints, causing the ruin of the masonry. By constructing these revetments with concrete, taking care to apply a strong exterior coat of plaster immediately, and to unite it perfectly with the beton, there will be nothing to fear from vegetation, and the talus of the wall will allow its thickness to be considerably lessened. This will be worthy of trial at those places in the north where the materials are not generally good, and where arenes are to be obtained.

When repairing revetments from which portions had scaled off, from the effect of vegetation, I had occasion to remark that sometimes the lime seemed to have disappeared from the mortar almost entirely; to such a degree that it was thought the lime had been fraudulently reduced in quantity in making the mortar. Examining these separated parts of the wall, I remarked that all the joints of the stones were filled with roots which had penetrated to a great depth. There remained hardly any thing but sand in the joints of the stones. I was led to believe from this that fat lime is absorbed by vegetation. I saw no such effect in masonry made of good hydraulic mortar. It is possible that the hardness of these mortars resists the development of vegetation; or that this kind of lime is less favourable than fat lime. In making revetments of concrete, giving them a good coat of plaster made of hydraulic mortar, of which the surface should be made very smooth, it seems to me that there would be nothing to fear from vegetation.

In the northern department of which I have spoken, the buildings are not more solid than the revetments. They are obliged to make them of bricks which are at the same time of bad quality and very dear. In many southern districts houses are made of *Pisé*. This kind of construction is not in my opinion solid enough for military establishments; and I doubt if it would succeed in the humid climate of the north: but I see nothing to prevent these buildings being made of concrete. I have shown that with

hydraulic mortar we obtain a strength approaching that of common bricks. The walls of houses constructed of concrete containing this kind of mortar would possess great solidity, and wherever arenes were at command and building materials bad, would be erected with great comparative advantage. The angles of the building, and the casements of doors and windows, should be made of factitious stone, and the walls should be covered with a coat of hydraulic mortar, coloured to resemble stone. The precautions indicated above, against too rapid drying, should not be omitted. It would be easy to make a trial of this kind, on some small building, or a guard room, kitchen, &c.

We often have to construct bomb proof buildings, for powder magazines, barracks and other establishments. In countries where the mortars are of bad quality, I am of opinion that it would be wrong to make them of concrete. When made of stones, or bricks, I have already said, that it seems to me necessary to use hydraulic mortar. I will add that when it is thought proper to make the arches of stones or bricks, I regard as indispensable, after the centre has been struck, to make all the masonry above these arches of concrete; this being, in my opinion, the only means of securing their future impermeability. This mass of concrete might, in fact, enable us to dispense with a plastered cap; but, for greater security, it will be best to put on a coat of plaster of about one inch in thickness. It is very important when these caps are in progress, to shield them from the sun. They are sometimes covered with a sail cloth; but this does not preserve them from hot air which causes them to dry too quickly. It would be better and cheaper, to cover them, as they advance, with moistened straw. When the caps have acquired sufficient consistence, they should be polished, and again covered with straw, which should be kept moist all summer. If the arches are to be covered with earth, this earth, at least in part, should be put on as soon as the caps have been polished.

There is still another use to which concrete may be applied with great advantage, namely in the abutments of suspended bridges. When there is not rock to which to attach the chains, it is necessary to build abutments; but these chains acting in an angle of about 45°, a great part of the tension is in a horizontal direction. If the mass of the abutment is of cut stone; or rubble masonry, the mortar not fastening the stones together strongly, this force may disjoin them horizontally. This lately happened to the suspended bridge built opposite the *Invalids* at Paris. I do not doubt that the masses of masonry forming the abutments would have been competent to resist a much greater force than they were subject to, if those abutments had been of a single piece each: but as they were constructed of cut stone and rubble masonry, and there had not been time for the mortar to dry thoroughly, the masonry separated into two parts near the middle of the abutment, so that the hand might be introduced between them. This I consider the explanation of the accident which made it necessary to demolish the bridge before it had been entirely uncentered. If the masses to which the chains were fastened had been of concrete, they would have formed a single, homogeneous, inseparable mass: it would have been necessary for the chains to have drawn it off entirely, or to have broken it, while, in the actual case, it was only necessary to disjoin stones that had but recently been united by mortar. When bridges of this kind are built it seems to me proper to make the abutments, to which the chains are to be attached, of concrete: and they should be erected a year in advance so that the substance may acquire sufficient solidity.

The beginning of autumn is the most favorable season for making concretes that are to be exposed to the air.

I will conclude by observing that the expense necessary to the composition of good mortars for concretes, must be encountered. In countries where the arenes are not very hydraulic, they may be mixed with hydraulic cement in proportions depending on the energy of the materials. As I have said above, it is more economical to encounter the requisite expense of good masonry, at once, than to execute it cheaply of bad materials.

I have thought it proper to enter into some details as to the advantageous use to be made of concrete in places where building materials are of bad quality; and to indicate some new modes of construction to be substituted for those now in use.

ARTICLE XVI.—*Summary of the Second Section.*

The experiments reported in the second section of this memoir, lead me to the following conclusions, as to mortars exposed in the air.

When I made mortar by using fat lime that had been lying slaked and moist for a considerable time, and sand only, I could obtain no satisfactory result, whatever were the proportions. In making mortars with sand, and fat lime just from the kiln, I could obtain only mediocre results. The lime I used was got from a carbonate of lime containing only a minute quantity of iron. It will be important to ascertain, whether, as I anticipate, similar results will be produced in other countries. Should the experiments in other places afford similar results, it will be necessary to abandon the practice of keeping fat limes lying slaked and wet for a long period, and to adopt that of using them fresh from the kiln.

The process of slaking lime announced by Mr. Lafaye, and that given by Mr. Loriot, afford no sensible amelioration with fat lime.

Hydraulic limes mixed with sand, produced very good mortars in the air, as well as in water. These limes must be used soon after the calcination, as they lose a great part of their energy. Mortars made of hydraulic limes afford a greater resistance when they are mixed with sand and hydraulic cement, than when mixed with sand only. Hydraulic cements, or other analogous matters, mixed with limes, restore the energy of those which had been too long exposed to the air; and augment the energy of those which are but moderately hydraulic.

Hydraulic mortars made of fat lime, sand, and hydraulic cements, or other analogous matters, are excellent when used in the air. When sand and cement, in equal parts, are added to lime, it is almost a matter of indifference whether the lime be used fresh from the kiln, or slaked to powder with a little water, and for some time exposed to the air in this state, or, having been slaked and lying wet for a considerable time. But if only a small quantity of cement is to be added to the mortar, it will be best to use the fat lime shortly after its calcination.

In countries where good natural hydraulic limes are to be had, they may be used with sand only, in making mortars for exposure to the air. When such limes are not to be found, instead of making artificial hydraulic limes, it will be preferable, as in the case of water mortars, to make the hydraulic mortar directly, by mixing fat lime with sand and hydraulic cement. The proportion of cement to be mixed in the mortar will depend on its quality, and the nature of the works to which it is to be applied.

Clay dust containing about one-fifth of lime appears to be less proper

for mortars that are to be exposed to the air, than for those to be placed in water: but a few hundredths of lime, far from injuring, have an advantageous effect in saving fuel, and facilitating the pulverization of burnt clays. Clay dust, and other analogous matters, should always be made very fine.

Arenes mixed with fat lime afford hydraulic mortars, which are very good in the air. When the arenes are feeble, they should be mixed with a little hydraulic cement.

When *clay dust*, *ashes*, *scoriæ of forges*, and *arenes*, have only weak hydraulic properties, they give to air-mortars but feeble tenacity. Before using these matters in the air, therefore, they should be tried by mixing them with fat lime, and plunging them in water, according to the process given in the first section. It is the more important to make such trials, because these substances are very dear, and some varieties of them produce no better effect than so much sand.

Fat lime and hydraulic lime do not seem able to bear as much sand as is commonly thought. Fine sand affords much better results than coarse, both in air-mortars and in water-mortars. Earthy sands must be avoided. In places where earthy sands, only, can be procured, they must be washed: but before resorting to this operation, we should be satisfied that these sands are not arenes. Should they prove to be arenes, they must be used in the state in which they are found.

The process given in the first section for the manipulation of water-mortars applies equally to air-mortars. No ill consequences need be apprehended from wetting the mortars to the degree requisite to their being worked with ease; nor, when they have become too stiff, from exposure to the air, from adding a little water, on reworking them. An excess of trituration, beyond what is required to mix the ingredients thoroughly, is altogether useless.

It does not appear that the Romans had any particular process for making their mortars. No masonry has survived to our day but such as was made of hydraulic lime, or of fat lime and hydraulic cements, or arenes (I speak here of masonry made of small materials.) An inspection of their mortars shows that they were often made with little care, proving that their good quality is to be attributed solely to the quality of the lime, or of the substances mixed with it.

If, in general, no better results are obtained with fat lime, than those obtained by me, the practice of making mortars of fat lime and sand only, should be abandoned. A small quantity of hydraulic cement, or of some substance of similar nature, should always be mixed in the mortar; that is to say, all air-mortars should be hydraulic mortars. The expense will be a little greater it is true, but there will be full compensation in the duration of the masonry. There is no economy in putting up cheap masonry which will require to be rebuilt at the end of a few years; and will need costly repairs, annually: it is much better, and really more economical, to encounter, at once, the expense which will secure to the work an indefinite duration, and exemption from all but trivial repairs.

Hydraulic mortars, whether made of hydraulic lime and sand, or of fat lime and hydraulic cement, or other similar substance, resist the inclemences of the seasons well, which makes them proper to form factitious stones. The art of making factitious stones is nothing more than the art of making good hydraulic mortars. This kind of stone may be easily made to possess, at the end of a year, a tenacity about equal to that of ordinary bricks, and

this tenacity will go on augmenting, for several years. The solidity of hydraulic mortars is favoured, and of course the solidity of factitious stones also, by keeping them moist during the first year. They should, therefore, be buried under ground, or placed in water, if their dimensions will allow; and when too large to be thus disposed of, they should be formed on the spot they are to occupy, and be enveloped in some material which may be kept wet. It would be proper to make their dimensions a little in excess, in order to bring them, subsequently, to their true dimensions, by cutting away the surface that had been in contact with the air. In order to avoid disagreeable colours, cements should be taken, which are but little coloured by the oxide of iron.

In countries where building materials are of bad quality, and where energetic arenes, or good hydraulic limes, are to be had, concrete may be advantageously employed, in the construction of revetments, underground rooms, aqueducts, and various buildings: this mode may also be employed, even where no arenes or hydraulic limes are to be found, provided the materials for making cements, can be procured at a moderate price.

It will be important, wherever works in masonry are to be carried on, to make experiments in order to ascertain, 1st, the quality of the several kinds of lime to be found in the neighbourhood; 2nd, whether it be best to use fat lime fresh from the kiln, or to slake it into vats, and allow it to lie for some time wet, as is commonly done; 3rd, the proportion of sand that gives the best mortar; and 4th, the quality of various arenes and cements to be found in the vicinity.

To make these various experiments, both for water-mortars and air-mortars, I think the essays should be submitted to trial, after about one year, with a machine like that used by me, and of which a drawing is added. It would be advantageous to make, in all places, the trials with prisms of mortar of the same dimensions, in order to compare the various results, and to ascertain the relative qualities of the materials, in different districts or countries. The great number of experiments I had to make, was the reason why I used prisms too small. I think that quadrangular prisms 14 inches long by 4 inches, (0.35m × 0.10m × 0.10m) would be of suitable size.

To this end the mortar should be moulded in boxes 14 inches long by 4.80 in. wide by 4.80 high: after a year, four-tenths of an inch should be cut from each face, and the prism be placed in two stirrups of iron, like those in the plate—the stirrups being twelve inches clear distance apart, and be broken in the manner pointed out in the first section. Similar prisms should be made of the best brick earth in the vicinity, which, after being burned, should be cut down to the same dimensions as the mortar prisms; these brick prisms being broken, the average weight sustained by them will serve to appreciate the resistance of the mortar prisms. Stone prisms should also be subjected to the same trial: these, when of good stone, will show a strength much beyond that of the best bricks: I doubt if mortars can be brought to afford a resistance equal to hard stone: but the strength of bricks may be easily attained, and that will give good masonry.

I must urge upon Engineers to study, in their several localities, the meterials most proper to make good mortars. The fabrication of mortars has been, for a long period, abandoned to a routine which has produced perishable masonry, requiring frequent repairs; and thus consuming funds which might have been applied to the construction of new work or the amelioracion of the old. Engineers should not consider it beneath them to be occupied in this kind of research: and they should leave behind them at each

place, a relation of the experiments they have made, and the results they have obtained. These operations require minute attention, certainly, but this will be recompenced by works of long duration.

(TO BE CONTINUED.)

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Mechanical power of the Pulley; in reply to the strictures signed G.

By L. H. Parsons.

Accompanying my essay on the "Mechanical power of the Pulley," in the October number of the Journal of the Franklin Institute, is an article, signed G, in which the writer assumes and professes to show, that I "labour under some misapprehensions" in supposing that the *movable pulley* is referable to the second kind of lever. The remarks are of such a character as appear to me to call for, and I presume I shall be allowed, a few words in reply.

After intimating that my piece was inserted as a matter of sufferance, the writer complains of the want of clearness in the expression of my views. I certainly regret that I failed of making my views intelligible,—for I cannot but flatter myself that the writer of the article, as well as every other reader, would, if he had understood my reasoning and illustrations, have agreed with me. I regret also, that he did not point out the passages, containing the obscurity of which he complains; so as to give me an opportunity, if possible, of making the matter clear.

At present, I do not feel called upon, or even at liberty, to attempt any further exposition or defence of the principle which I undertook to establish:—for my reasoning has not been answered, or even a single point alluded to by G. Whether sound or fallacious, the whole of it remains untouched. I attempted to show that a *movable pulley*, connected at one side with a stationary cord, and at the other, with the power, operates upon the principle of a lever of the second kind; also, that the same holds true with a cord passing over a solid body *without* a pulley. Instead of pointing out any fallacy in my reasoning, or, in any way, showing that a real pulley *does not* act upon that principle, G. supposes an "imaginary machine," in which, to use his own language, "the points considered as the points of application of the power and weight respectively, *coincide!* and of course, move through equal distances, in equal times," and concludes that "here there is no lever." Very true; and what is there, I ask, in this "imaginary machine" that can claim any resemblance, even in theory, to that known by the name of the pulley? I must confess that I can discover nothing. If the points referred to, *coincide*, and coincide they must by the supposition, the machine (if it be called one) is neither more nor less than a single line attached to a weight. Consequently, no reasoning in regard to it, has any thing to do with the subject in hand. If by supposing all the parts of the machine to be reduced to a single mathematical point, it can be shown that the *pulley* is not a lever, then by the same process, it can be proved that the *lever itself* is not a lever. Instead of "an infinitely fine wire," why might I not as well suppose an infinitely short bar or rod, and then say that "here there is no lever, since the points before considered, as the points of application of the power and weight (and fulcrum also) respectively, now coincide, and of course, move through equal distances in equal times."

For myself, I can conceive of no use in thus refining the matter down to an infinitesimal, even if the supposition did not destroy, or affect, the essential elements of the machine; which, however, it certainly does, in the case before us. Why not suppose a real, or at least a possible machine? Suppose a real bar (I care not how short, provided it has sufficient length to admit of a point lying half way between the two ends, and not *coinciding* with them) with one end suspended by an immovable cord, and the other by one that is movable, or by the hand; and then suppose a weight to be attached to the centre of this bar; (see the bar A, C, in the diagram, page 244) will G. say that "*here* there is no lever? "If not, will, or can any difference be pointed out between it and the movable pulley? If G. will procure (as I have done for the purpose of experimental illustration before a class) a pulley, five or six inches in diameter, with a straight bar of similar length, attached to its side, the centre pivot passing through both the bar and the pulley, and the apparatus so constructed that the cord may easily be removed from the edge of the pulley and attached to the ends of the bar, I have no doubt he will admit the existence of the principle in question.

G. says, "several authors have explained the relation between the power and the weight in the single movable pulley, on the principle of a lever of the second kind. I am aware that some authors have spoken of it in general terms, as being a lever; but I had supposed that the stumbling block always consisted in neglecting to transfer the fulcrum from the centre to the periphery of the pulley. I should be glad to be referred to an author who expressly assigns the fulcrum to the point where the stationary cord comes in contact with the pulley.

Not long since, I received a communication (in reply to some suggestions of mine on this subject) from a learned Professor, who is the author of a valuable and popular treatise on Natural Philosophy, in which he explains the pulley in the usual way. He expressly admits that "the movable pulley is a lever of the second kind, where the power is applied twice as far as the weight from the fulcrum;" but he does not consider the matter of sufficient importance to call for any change in the rationale. For my part, I think truth should be preferred to error, even in the most trifling matters, especially in Philosophy; and even though old associations and the sanction of great names, be on the side of error. But a subject, involving a fundamental principle in Mechanics, cannot be considered trifling.

Having pointed out what I conceived to be the irrelevancy and unsoundness of G's. strictures, I have now in conclusion, only to say that I am willing to leave the argument, just as it is, in the hands of my readers, with this single request—that they re-examine, carefully, the two articles, to which this communication has reference. Let the enquiry commence, (where it ought,) with the thing itself, a real machine, instead of that which has no actual resemblance to it, a non-entity, and I have no fear for the result. If any defect can be detected in my reasoning, or any unfairness in my illustrations, I expect and desire it to be exposed.

November, 1837.

Remarks.—The foregoing communication, from some cause unknown, was not received at the Institute till it was too late for insertion in the last number. Whatever may have been the impression produced by the observations on the former paper of Mr. Parsons, certainly nothing more was in-

tended than an attempt to rectify what was conceived to be "some misapprehensions" into which he, in connexion with many others, have fallen with regard to the best mode of reasoning in demonstrating the theory of the pulley. The question at issue is considered as worthy of philosophical discussion, and the writer of these remarks does not doubt from the last sentence of Mr. Parson's communication, that, as an instructor, having a high regard for the truths of science, he will duly appreciate every attempt, fairly designed, to render those truths triumphant.

The want of clearness to which allusion was made, occurs in the second paragraph of page 244, in which it is asserted that the cords, though "practically indispensable," are not "theoretically, an essential element." It is doubtful whether the author means to convey the opinion that an elementary notion of a pulley could be given to a pupil without the supposition of a determinate *flexible* connexion between the two points to which he wishes principally to direct the attention, viz: the two extremities of his lever. How the fulcrum of the straight bar which (as he states above) he attached to his pulley, was made to ascend, during the experiment, he does not inform us. If it truly represent any given diameter of the pulley while in motion, it must necessarily descend, and without a constant downward motion of the imaginary fulcrum, no motion of the weight could ensue. But is not a constant motion of the fulcrum inconsistent with the *elementary* notion of a lever? If the weight *constantly* rise, what is the "time being" during which the fulcrum is "vertically stationary?" To make out a case, therefore, it seems that he has at last to come to "infinitesimals," and this appears at least as objectionable with respect to time, as to space or distance.

If it be alleged that a constant movement of the fulcrum is not incompatible with the definition of a lever, provided the motion of the weight and the power be relatively more rapid, as in the rowing of a boat, I would still urge, that as a dynamical machine, the oar would be *more* effective were the fulcra fixed points, as they might be were the boat in a canal so narrow that the oars could reach the shores, and lodge at every stroke against a fixed obstacle; and that just in *proportion* to this stability is the oar to be considered as a lever of the second kind, and no farther. The idea of a *perfectly* unstable fulcrum seems to me to divest the lever of the attribute of power, and that an imaginary condition of simple statistical equilibrium is an insufficient postulate as a basis of reasoning in a case like the present.

But the error (if it be one) of considering the movable pulley as a lever of the second kind is not peculiar to Mr. Parsons. As he wishes a reference to authors that have so considered it, I quote a few of those which happen to be at hand, merely changing the letters in their references to figures, to suit the one given by him in his first communication in the last Vol. page 244.

"The movable pulley is fixed to the weight W, and rises and falls with it. In comparing this to a lever, the fulcrum must be considered as at C; the weight acts upon the centre D, and the power is at the extremity of the lever A. The power, therefore, being twice as far from the fulcrum as the weight is, the proportion between the power and the weight, in order to balance each other, must be as 1 to 2."—*Imison, Elements of Science and Arts, Vol. I, p.* 51.

"We have now to show that the movable pulley acts like a lever of the second order. Let the movable pulley be fixed to the weight W, with

which it rises and falls. In comparing it with the lever alluded to, the fulcrum must be considered as at C; the weight acts upon the centre D, by means of the neck D H; the power is applied at A, and the line A C will represent the lever."—*Smith's Panorama of Science and Art, Vol. I, p.* 308.

"Maintenant la droite A C peut etre considerée comme un lévier du deuxième genre; son point d'appui est en C, la puissance est censée agir en A, et la résistance se fait sentir en D dans le sens vertical D H."—*Mollet, Mécanique Physique, p.* 366.

"When used in this manner, (the fixed pulley,) the pulley is but a method of altering the direction of the applied force. But if inverted, so that the end of the line E is attached to a fixed point, the weight or resistance being at D, and the applied force acting upwards, the line from E being permanently fixed, it will become a fulcrum; and the horizontal radii of the circle assume the position of a lever of the second class," &c.—*Nicholson's Operative Mechanic, Phil. edit. p.* 11.

"A C represents a lever of the second kind, whose support is at C, a fixed point; the rope C E being fixed at E. And the weight W acting at the middle of A C, and the power acting at A, twice the distance from C; therefore the power P is to the weight W as $\frac{1}{2}$ A C to A C; or as 1 to 2."—*Emerson's Works, Vol. VII.*

"This power (the pulley) may likewise be explained on the principle of the lever. If the pulley is fixed, it is a lever of the first kind; if movable, it is one of the second kind.

"In the movable pulley the power is applied at A, the weight at D, and the fulcrum is at C; therefore since the length of the arm A C is double that of D C, a power P applied at A will sustain a weight W applied at D twice as great as P."—*Willit and Smith's, Elementary Treatise on Nat. Phil. Philad.* 1830, *p.* 44.

In conclusion I cannot but agree with the author of the treatise on mechanics in the "Library of Useful Knowledge," "that such investigations (establishing the conditions of equilibrium by considering it as a lever) are founded on wrong principles, although their results happen to be true;"—and with Dr, Gregory in his treatise on mechanics, Vol. I, p. 88; who states, with approbation, that "Professor Hamilton and others have been of opinion that the pulley cannot properly be considered as a lever of any kind."

G.

For the Journal of the Franklin Institute.

Result of some experiments on Temperature, connected with the use of Prof. Olmsted's Stove. By J. Griscom.

Since the introduction of anthracite coal as one of the main sources of domestic heat in a large section of the United States, the number and variety of contrivances for facilitating its combustion are scarcely less amusing, than were the numerous determinations of its total unfitness for the purposes of a common fuel, and the numerous grates that were pulled down, after giving it, as was supposed, a fair trial. The success which has since attended the use of this material, the demonstration of its admirable adaptation to all the wants of the parlour, the bed room, and the kitchen,—its extensive employment in manufactories, and the vast enterprise now manifested in the exploration and transportation of

it, are flattering evidences of the skill and energy with which obstacles are overcome by our citizens, and the bounties of nature, so lavished upon our country, turned into the channels of its prosperity.

No species of fuel hitherto tried by man, of equal calorific power, can be compared with the anthracite of Pennsylvania, for the combined qualities of cleanliness, durability, and economy of time and money. The recent application of it to the reduction of iron ore, seems to form a climax in the discovery of its beneficial qualities. But we know of no fuel which requires so much judgment in the proper management of it. Its great compactness demands a nice regulation of the draught, and admission of the air requisite to maintain its free combustion.

For the purpose of saving fuel, and consequently the labour and trouble of attendance, stoves are preferable to open grates. They are also much more effectual in keeping up the temperature needful to entire comfort in cold weather. In a properly constructed stove, no heat is absolutely lost, for no more need be allowed to escape into the chimney than is necessary to support the warmth of a column of air a few degrees above that of the external atmosphere, in order to produce a sufficient draught. The equable diffusion of heat throughout an apartment, is best accomplished by a spreading jet, or column of heated air, and when this can be combined with the operation of a stove, it is difficult to perceive, so far as the production and diffusion of heat are concerned, what further improvement is to be expected.

Without pretending to much practical information relative to the numerous modifications, patented or not patented, which have been given to stoves for the purpose of burning anthracite, I would state, that having occasion to make a selection, I resolved to try the stove of Professor Olmsted, not with a view to assert its superiority, but by a register of its effects, to furnish data from which any one may draw conclusions satisfactory to himself.

My room, which is used both as a study and a sleeping room, is about eighteen feet square. The house is situated on elevated ground, between nine and ten miles from Philadelphia, on the Columbia Railroad. The stove, or furnace, is a cylinder of Russia sheet iron, lined with fire brick. The internal diameter is eight inches, and the height of the cylinder from the floor is two feet seven inches. It stands two feet nine inches from the chimney, the pipe passing through the chimney board of a small fireplace. The stove is connected laterally, with a double cylinder or drum, of similar sheet iron, into which the draught is turned as soon as the fire is well kindled, by closing a damper in the pipe. This drum or radiator, together with the pipe, increases the area of heated surface, in addition to that of the stove or furnace, to about eighteen square feet. The thermometer in the room hangs against a partition wall at the distance of about twelve feet from the stove, and four and a half from the floor. This was regularly compared (in the following table) with a thermometer in a northern exposure on the out side of the house.

Date 1838.	External Thermometer.			Internal Thermometer			Pounds of coal consumed.
	Morn.	Midday.	Even.	Morn.	Midday	Even.	
	Degs.	Degs.	Degs.	Degs.	Degs.		lbs.
Feb. 11	19			62			
12	26				66		30
13	25			50			30
14	21			57			31
15	10	18	15	56	63	64	
16	20	20	19	46	60	60	30
17	8	18	14	44	62	64	32½
18	14	24	20	43	65	64	34
19	24	28	17	45	68	66	31½
20	15	22	10	45	70	66	32
21	3½	18	12	43	68	64	31
22	9	26	16	55	68	62	32½
23	14	26	24	52	66	64	
24	18	22	12	58	70	68	31½
25	6	18	12	54	72	66	31½
26	7	26	11	45	66	70	31
27	11	32	18	52	67	68	30
28	8	24	24	49	74	62	31
March 1	13		24	49		66	32
2	20	32	22	56	66	70	
3	15	35	22	49	66	66	32
4	18	40	26	49	72	66	32½
5	32	44	36	55	69	71	
6	34	48	37	53	66	66	34½
7	32	36	33	56	69	72	33
8	32	33	32	53	66	69	
9	32	46	34	57	64	66	32
10	33	48	37	57	67	66	
11	32	48	38	57	66	68	31
12	34	52	40	56	69	66	
13	32	56	36	56	65	65	

Average temperature during the 31 days—

Out of doors,

Morning	19.9
Midday	32.3
Evening	25.5

In the room,

Morning	51.
Midday	65.8
Evening	66.1

Average quantity of coal consumed per day, 21.42 lbs.

Average coal consumed per day during the last nine days, when the external thermometer was nearly at the freezing point every morning, 14.4 lbs.

Average consumption the first 22 days, when the thermometer was constantly below freezing, 24.2 lbs. per diem.

It thus appears that estimating the stove to be in action during five months, or 150 days, commencing with the first of November, and ending with the last of April, the quantity of coal required, when the external thermometer averaged 20° of Farenheit, would be 3213 lbs., or less than a ton and a half; that if the range of the thermometer during the winter should average 32° (the freezing point) the quantity required would be less than a ton;—that the weather must be severely cold to

require a rate of combustion exceeding a ton and a half;—and that this quantity would be sufficient to maintain the temperature of a room 18 feet square, at 60° during the night, and at 66° during the day.

But there are two other advantages in the construction which Professor Olmsted has adopted. *First*, By increasing the extent of heated surface, so as to prevent the iron from ever becoming so hot as to lose its polish by oxidation, and thereby not only to become, itself, rapidly deteriorated, but also greatly to injure the quality of the air. *Second*, The cold air which enters the room, and necessarily forms the lower stratum, flows towards the stove, and ascending in the open and heated cylinder of the radiator, forms a rising column of warm air, which, by its diffusion, produces a mild, summer heat throughout the chamber, rendering unnecessary the evaporation of water to counteract the usual deleterious effects of a hot stove. I found, on one occasion, the temperature of the air in this heated column to be 150°, while at the same time the thermometer, with its bulb resting on the last joint of the stove pipe, sunk to 110°, the thermometer in the room being then 70°, and outside of the house 36°. Both the furnace and the radiator may be too hot to be endured by the hand, while the end of the pipe remains barely warm.

It was no part of the design of this trial to furnish a laboured eulogium of the particular kind of stove in question. There may be other forms which would produce similar results. I can only say that I know of none. But in the use of any close stove for burning anthracite, care must be taken, by a due regulation of the draught, to prevent the escape into the room of the gases which arise from combustion. The truth is, that, heat a room as we may, and especially a bed room, the air must be gradually and constantly renovated to prevent deterioration, and to preserve it in a state perfectly fit for free and healthful respiration. Hence the great importance of good ventilation. This, in the case above described, was effected by leaving open, as occasion required, a hole made for a stove pipe near the ceiling, and opening into an adjoining flue of the chimney. By these precautions I slept constantly in the room during the experiment, with the door shut, without any inconvenience, except having to rise once or twice to open the ventilator, when it had been left closed on going to bed. Such an opening into a chimney can be easily regulated by a sliding valve, and ought (unless there be some equivalent) to form an appendage to every close sleeping room.

Progress of Physical Science.

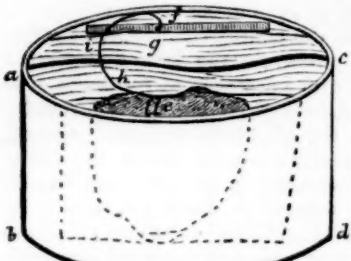
Origin of Mineral Veins.

Extract of a letter from Robert Were Fox, Esq. to J. Griscom.

Falmouth, 11 mo. 30th, 1837.

"My theoretical views relative to the origin of mineral veins, have derived strong confirmation from some of my subsequent experiments, one of which I will refer to, because it bears on the symmetrical structure of sedimentary rocks. On exposing clay which had been pulverised, and afterwards moistened with acidulated water and worked up into a plastic state, to long continued voltaic action, it assumed the *laminated* appearance of clay slate.

Let *a*, *b*, *c*, *d*, represent an earthenware vessel, *e* copper pyrites, and *f*, a plate of zinc, connected by a copper wire *e*, and separated by a wall of clay, *a*, *c*, *g*, *h*, the copper and zinc cells having been filled with acidulated water. An apparatus thus prepared was set aside for some months, till the clay had become dry, and on its being taken out of the vessel, it separated into portions as indicated by the parting line *a*, *c*, each portion having *laminæ* in the same direction, shown by the finer lines, so as to give the whole mass a schistose appearance. A second experiment indicated precisely the same phenomena.



It is evident that the divided portions of clay *g* and *h*, were, like the metallic bodies, in opposite states of electricity, and one of them, consequently, in a more favourable state than the other, for the deposition of metals &c. from their solutions. This is precisely the reason which I have ventured to assign for metals being found in some rocks, in preference to others, and this often depending more on the *positions* of the rocks, or strata, with respect to each other, than on their natures merely; the numerous lamina in the clay also show that a series of pores may be formed in earthy matter, and serve to explain why insulated portions of metals, copper and the oxide of that metal, for instance, occur in masses of clay which have been long submitted to voltaic action after they have been moistened with a solution of the sulphate of copper.

The experiments I have referred to, seem to bear directly on the cause of the lamination and structure of rocks, and we may perhaps be enabled to infer from their lamina, the direction in which the electricity has principally acted upon them, its influence having apparently been greater on the more heterogeneous sedimentary rocks, than on the more homogeneous ones, in which molecular attraction seems to have predominated.

I send a polytechnic report for 1834, containing a description of my dipping needle, although some improvements have been made since this account was published.

This instrument has been used by Lieut. Burnett, at sea, on his voyage with Sir John Franklin, to Van Dieman's Land; the results thus obtained, are highly interesting, and he has sent a very satisfactory report of its performance.

I have also received most favorable and unqualified reports, of a similar instrument sent on Capt. Back's expedition towards the N. W passage; and of another which accompanied Colonel Chesney on the Euphrates.

I mention these facts as they may induce one of your Institutions to have one of these instruments.

They are made by Thos. Jordan of this town, who has supplied the admiralty and ordnance Boards with them for observations at sea, and on land, and I believe that no one in England makes them so well, or at so cheap a rate, his price is from £14 14*s* to £30, according to circumstances; the lower priced ones are not calculated for observations on the magnetic variations, but will answer perfectly for the dip and intensity."

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Notice of three specimens of Garnet. *By* THOMAS ELDER, JR.

1st. *Melanite.*—The chief localities of the black garnet, or melanite, hitherto known, have been Vesuvius, where it is imbedded in lava, and near Rome. Specimens of the same have lately been found on the Round Top mountain, about a quarter of a mile N. E. of Hummelstown, Dauphin county, Pa., in a trappean rock belonging to the range of the Conewago hills. The crystals are very distinct, presenting the usual dodecahedral form of garnet, with their edges sometimes replaced by a plane, and are therefore a combination of the dodecahedron with the icosatetrahedron. They are generally of a rich velvet black colour, opake, and with a resplendent lustre; a few, however, are greenish brown and translucent on the edges. The irregularities of their cleavage distinguish them from other varieties of garnet.

2d. *Cinnamon Stone.*—This beautiful mineral from Ceylon, has long been known and classed with the garnet from its chemical composition, its crystalline form having never been observed. I lately saw a specimen obtained from Mr. Nuttall, found on the line between New Jersey and New York, which is well worthy of particular notice, in consequence of its form. The crystals are remarkably distinct, with the brilliant surfaces and sharp edges of the dodecahedron, which in most cases are replaced by planes, and in a few instances the edges of this new plane are replaced by minute faces. They present, therefore, a combination of the dodecahedron and icosatetrahedron, with small planes of the hexaicositetrahedron. The lustre is more brilliant than that of the precious garnet, and the colour much lighter than the cinnamon stone from Ceylon, while the well formed crystals are nearly transparent. Experiments by the blowpipe prove that the quantity of iron present is smaller than is found in any other variety of garnet, excepting the Grossular.

3d. *Colophonite.*—This mineral is generally found in the form of irregular coarse grains, aggregated together; but I lately saw a specimen distinctly crystalized and presenting an unusual combination. It has the form of trapezoidal garnet, (icositetrahedron,) but where the faces of the dodecahedron should appear, may be observed a low four sided pyramid, which would make a solid of $12 \times 4 = 48$ planes. It is therefore a combination of the icositetrahedron with the hexaicositetrahedron, and without a single plane of the dodecahedron,—a combination of very rare occurrence, excepting in the diamond.

Philadelphia, January 27, 1838.

Melanites rivaling in beauty those of Frascati, have been found at Franklin, New Jersey. They have also been found at Germantown. An analysis of the Franklin Melanite was made by Henry Seybert, and published in Silliman's Journal, Vol. VIII, p. 300. G.

Franklin Institute.

Committee on Science and the Arts.

At a stated meeting of the committee on Science and the Arts, held April 15th, 1837, a circular letter from the Hon. Levi Woodbury, Secretary

of the Treasury, was received, proposing inquiries on the subject of a system of Telegraphs for the United States, and

At a special meeting held on the 18th of the same month, the following report was read and adopted.

Report on Telegraphs for the United States.

The committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic arts, to whom was referred the communication of the Secretary of the Treasury on the subject of telegraphs, think it would be premature, if not impracticable, to enter, at present, into minute details as to the matter referred to them, and judge that the Institute would fulfil the wishes of the Secretary more effectually by making to him an early communication of their general views, and leaving to a future correspondence any further developments that may be required of them. It is under this impression that the committee have hastened to prepare the following report:

1. *Kind of Telegraphs.*—The ample details given in Rees's Cyclopedia and other works as to the different schemes employed or proposed for telegraphs, render a description by the committee unnecessary. Only one of these telegraphs seems to have stood the test of long experience: it is that invented by Chappe, and employed in France since the year 1793. It is composed of three arms: one about eight feet long, movable around its middle point; and two of half the length, attached by their ends to the ends of the first, and also movable; the movements being communicated, from within the building, by cords and pullies. This telegraph is capable of giving one hundred distinct signals. It is believed, however, to be unnecessarily complicated, and has the disadvantage of not being suited for night signals.

The committee are, therefore, disposed to recommend a much more simple instrument, nearly similar to one lately introduced by M. Chateau, in a line of telegraphs which the Russian Government is erecting between Petersburg and Warsaw, and which is described in a late number of the Petersburg Transactions, by M. Parrot, together with a scheme of his own, almost identical with it, on which he had made successful experiments many years before.

This proposed telegraph consists of a single arm, or *indicator*, which should be about nine feet long and one foot wide, with a cross-piece at one end, about three feet long and one wide; the whole arm being movable about an axis at its centre. The arms are formed like Venetian shutters, and are painted a dead black: the apparatus and fixtures about it being white.

The movements may be communicated with ease and certainty, either by an endless chain passing over a wheel on the axis, and a wheel in the building; or by bevil wheels on the axis, and on a vertical bar passing from the building; or by a cog-wheel on the axis, and an endless screw on a vertical bar.

For night signals, three lamps are used: one swinging beyond the end of the arm; the other two beyond the ends of the cross-pieces.

2. *The Signals.*—The signals are given by the different positions of the arm of the telegraph. M. Chateau used only eight, but M. Parrot, by experiments in which the Emperor Alexander was an observer, de-

monstrated that twelve positions, distant 30° apart, could be readily distinguished. By an appendage (which will be proposed) to the telescope, all doubt on this subject will be removed.

Now it is believed that twelve fixed signals, together with those which may be given by certain motions of the arm, are abundantly sufficient for all telegraphic communications, whether alphabetical or numerical.

For this purpose, let the twelve different positions represent the following numbers and letters:

1	2	3	4	5	6	7	8	9	10	11	12
a	*b*	*c*	*d*	*e*	*f*	*g*	*i*	*l*	*m*	*o*	*s*
	p	*k*	*t*		*v*	*j*	*y*	*r*	*n*	*u*	*x*
	ph	*q*	*th*		*w*						*z*
		ch			*wh*						*sh*

The *h*, being only an aspirate, is omitted.

To indicate the separation of words, the arm may be vibrated twice, namely, one space (30°) to the right, and one to the left of the signal, and then carried to the first letter of the following word. To repeat a letter, the arm may be turned a space to the right, and then immediately brought back to the first position. To indicate that signals of numbers are to be given, the arm may be turned to the right, entirely round, and as much farther as may be necessary to carry it to the position 10, which is the 0 of numerical signals. To separate numbers, the same sign may be used as for separating words. To indicate that the signals of numbers are completed, the arm may be made to revolve entirely round to the left. When a wrong signal is given, the fact may be indicated by moving the arm backward and forward once, a distance of 90°, &c.

Suppose, now, the following signals to be seen and noted down.

4, 5—5, 10, 10, 5, 10, 8—1, 12—9, 1, 10, 4, 5, 4—1, 4—2, 1, 9, 4, 8, 10, 11, 9, 5—6, 8, 4—ɔ17,000c—10, 5, 10.

Taking the upper letters of the key, the despatch would be as follows:

De emmemi as lamded ad Baldimole, fid 17,000 mem;

Of which the true reading may be seen, even without the further aid of the key, to be this:

The enemy has landed at Baltimore with 17,000 men.

To prevent the discovery of the key, it may, when secrecy is important, be changed from time to time, without difficulty or inconvenience, since it is only at the extreme stations that it need be known.

If the system of signals, by a telegraphic vocabulary, be found most desirable, it will only be necessary to use the telegraph to indicate the numbers corresponding to the words in the vocabulary. In this way, if the ordinary decimal notation be employed, 999 words may be indicated without any one requiring more than three signals, 9,999 without more than four. But if the duodecimal notation be used, 1,463 words may be indicated without exceeding three signals for each, and 16,104 without exceeding four.

3. *The telescopes.*—For the telescopes to be used, M. Parrot recommends an achromatic object-glass of 3 inches diameter and 3 feet focal distance, and a double concave eye-glass of an inch and a half foca

distance. This is, in fact, a Galilean telescope, of the simplest construction, and will have a magnifying power of 30. The inconvenience of a very small field of view is of no consequence in this case; and the property of giving an erect image, with but two glasses, is perhaps of some importance.

Still the committee are disposed to give the preference to the common astronomical telescope, which has only the inconvenience (if it be one) of inverting the image, and which allows the use of an appendage deemed to be of some importance. This is a set of cross-hairs placed at the focus of the eye-glass, to correspond with the twelve positions of the arm of the telegraph, and thus pointing them out without the possibility of mistake. The true numbers, corresponding to the positions as seen in the telescope, may be marked on a diagram placed before the observer; so that, in calling them out, he will not be exposed to any mistake in consequence of the inversion of the image by the telescope, or by the back and front view of the telegraph.

The telescope, being fixed in its position, will be, of course, without the ordinary arrangements for motion. It should be placed entirely within the building; its object end being inserted into a hollow cylinder of wood passing through the wall, and painted black on the inside, so that all stray light may be kept from entering into the telescopes, and distracting the view of the observer.

It is scarcely necessary to add that there must be two telescopes at each station.

4. *Distance of telegraphs.*—The mean distance of the French telegraphs is two leagues, or six miles. In the experiments made by Parrot, and in which the image was very distinct, the distance was ten wersts, or about 7½ miles. The distance must be, in some measure, determined by the suitableness of the stations in other respects; but the maximum should not probably exceed 7½ miles, or the mean, six.

In selecting the stations, care must be taken that there be no considerable deviation from the front view of the telegraph on either side; and that it may be seen, from the adjacent stations, projecting against the sky.

5.—*The time of signals.*—In the French telegraph, the time required for each signal is estimated at 20 seconds; but it is believed that the simple signals of the proposed telegraph can be made and repeated much more rapidly; each signal in the former requiring three movements, in the latter only one. Far greater attention, morever, is necessary in the French telegraph, to see what is the true signal made; and this also requires time.

M. Parrot, from his experiments, estimates that it will require three seconds to see with certainty, and to dictate a signal made; three seconds to repeat it; and three to remain till it be repeated at the next station: in all, nine seconds—say ten—for each signal.

A line of telegraphs from New York to Washington would require about 40 stations; hence a signal made at New York would be repeated at Washington at the end of 400 seconds, or 6⅔ minutes. A despatch of 100 signals would require 1,000 seconds, or 16⅔ minutes at the first telegraph, and would be communicated to the last at the end of 1,400 seconds, or 23 ⅓ minutes.

6. *Telegraph buildings.*—On the line of telegraphs the buildings may be of wood, about 22 feet square, two stories high, and with a roof in the form of a quadrangular pyramid, surmounted by a small platform. In such a building it is judged that the arrangements for the telegraph, and for the necessary accommodation of the operators, may be made. In the cities, the telegraph must be placed on the top of some suitable building of considerable height.

7. *Men and officers.*—In urgent cases, three persons ought to be employed at each telegraph while it is in operation; one at each telescope, and one to make the signals. The observers may easily record the signals as they see them—if, indeed, this be necessary. In ordinary cases, two operators, or even one, will be sufficient; but as a lookout should be kept constantly, both day and night, less than three persons ought not to be employed at each station.

At each *principal* station there should be a secretary. Every ten stations should have a superintendent; and, if the system be considerably extended, there should be a director-general to take charge of the whole business, with book keepers and clerks to assist him.

8. *Estimate of cost.*—Although the committee cannot pretend to accuracy in their estimates of the cost of establishing and maintaining a line of telegraphs, they have thought that even an imperfect approximation might be deemed of some interest and importance, and they have accordingly prepared the following:

At each station on the line.

Cost of ground for the building and enclosures	$ 100	
" building	1,000	
" necessary furniture	200	
" well and pump	100	
		$ 1,400
Cost of telegraph and fixtures	$ 300	
" two telescopes	100	
" clock	20	
" transportation and putting up	80	
		500
contingencies		100
Total *first cost*		$ 2,000

Annual expenses of each station on the line.

Salaries of the operators, which may be a man and his family	1,000
Fuel	50
Oil	50
Contingencies and repairs	200
	$ 1,300

Annual expenses for officers, &c.

Salary of Director-General - - -		2,500
each Superintendent - -	1,000	
Horse and traveling expenses, extra	300	
		1,300
Secretary at principal station		1,000
		$ 4,800

Estimate for a line from New York to Washington.

36 telegraphs, at $2,000 each - -	72,000	
4 city telegraphs, at $5,000	20,000	
		92,000
Contingencies, and general superintendence of erections - - - - -		8,000
Total prime cost - -		$ 100,000
Annual charge of 40 telegraphs, at $1,300 each - -		52,000
Five superintendents, viz: two between New York and Philadelphia: two between Philadelphia and Baltimore; one between Baltimore and Washington - - - - - - -		6,500
Four Secretaries at the four cities - - - -		4,000
Total annual cost -		$ 62,500

9. *Selection of lines of Telegraph.*—The lines of most obvious necessity are those from the bays, along the rivers, to the great cities. As a general line, one from New York to Washington would be of great interest and importance. If found successful, lines might be afterwards extended to other great points.

For the location of the stations, it would seem particularly suitable to employ the services of the corps of topographical engineers.

10. *Experimental telegraphs.*—In conclusion, the committee would respectfully suggest to the Secretary of the Treasury to consider the propriety of causing two telegraphs to be erected, in which careful experiments may be made on all the points that bear upon the general question submitted to him by the House of Representatives; and the services of the committee, in erecting the telegraphs and conducting the experiments are hereby offered to him, should he think proper, and feel himself authorized to act upon this suggestion.

By order of the committee,

WILLIAM HAMILTON, *Actuary.*

Philadelphia, April 18th, 1837.

Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN JULY, 1837.

With Remarks and Exemplifications by the Editor.

148. For a *Rotary Press for pressing Woolen and Cotton Goods;* Moses Bayley, Salisbury, Essex county, Massachusetts, July 5.

A cast iron steam box is to be made, the upper side of which is to be concave from end to end, so as to receive a cylinder, between which and the box the pressing is to be effected. The length of the box must be equal to the width of the cloth to be pressed. The cylinder, adapted to the concave, is made to fit it exactly by a covering of cloth; a roller to receive the cloth as it is pressed, by passing between the cylinder and concave, lies upon, and extends along said cylinder. When hot pressing is to be effected, steam is let into the steam box, the cylinder turned by proper gearing, and the cloth passed through, and rolled up, as indicated.

CLAIM.—"What I claim as my invention in the within described apparatus for pressing cloth, is the using of a metallic box so formed as that a pressing roller may be made to revolve within a concave extending along it, and into which box, steam or other heated material may be admitted when required; the whole constructed for the pressing of cloth, either hot or cold, substantially in the manner herein set forth."

149. For a machine for *Thinning Cotton in the Rows whilst Growing;* John Weaver, city of Washington, July 5.

This machine is nearly identical with one for the same purpose, patented by Jordan Gatling, on the nineteenthof June, 1835, and noticed at page 50, Vol. XVII. The slight difference consists in a revolving harrow, which it is not necessary to describe particularly, and to which the claim is limited.

150. For a *Pistol Knife, or Cutlas;* George Elgin, New York, July 5.

The blade of the knife, or cutlas, extends back on the lower side of the pistol barrel, to which it is firmly attached, and it extends forward of the barrel, to any required distance, its back still being in a line with the lower side of the barrel, so as to be entirely out of the way when the pistol is fired. The claim is to the combining of the pistol and blade in the manner described.

151. For an improvement on the *Axle and Thorough Box for Carriages* of various descriptions; William Slicer, Baltimore, July 5.

The particular arrangement of the respective parts of the box and axle would require a drawing for their explanation. The claims are to "the extension or projection of the box back of the hub, by which I use an axle with an arm and box of extra length. The outer form of the box, being constructed with a large flanch, or collar, against which the hub is firmly fixed by a nut on the small or outer end of the box, and against the outer end of the hub. The method of fastening the box in the hub by a nut, coupling, or other fastening, on the outer or small end of the box. Using the outer end of the box, by stopping it with a

screw or otherwise for the point of bearing, to prevent the wheel from running too far back on the axletree. The use of this or any other form of axletree, without collar, washer, shoulder, or other bearing, except the point of the axle. The use of this conical or pointed axle without a nut or linch-pin, or other fastening on its outer end.

152. For an improvment in the *System of Cutting Garments;* Andrew Wiswell, Exeter, Rockingham county, New Hampshire, July 11.

The illustrations of this system extend through six sheets of drawings, which, as we have not taken the trouble to understand, we cannot explain.

153. For a *Tobacco Press;* James T. Bowman, Pattonsburg, Botetourt county, Virginia, July 5.

The follower of this press is brought down by a screw in the usual manner, and the pressing is effected in a number of cells, or separate compartments, divided from each other by sliding partitions. The pound, or other rolls, to be pressed, are put into the cells, each with a separate block upon which the follower is to act. There is a contrivance for elevating the tobacco in the cells, and the sliding partitions, simultaneously, by means of a lever beneath them. The claim is to the "press for pressing tobacco, made and operating substantially in the manner of that herein described; that is to say, having sliding partitions which can be raised so as to form separate cells for the reception of tobacco, and withdrawn for its removal after it has been pressed."

154. For a machine for *Spreading Lime, Ashes, and other kinds of Manure;* Francis H. Smith, Baltimore, July 5.

The material to be spread is put into a cart, the bottom part of which, about a foot in the rear of the axle, is formed into a hopper, within which two rollers, reaching from side to side, revolve by means of cog-gearing moved by a driving cog wheel upon one of the hubs. The rollers are to be of iron, and one of them is to be fluted, or armed with protuberances projecting out about three-fourths of an inch; the other may be smooth: one of the rollers is borne up by a spring, which is very strong, but will give way should a stone too hard to be crushed pass between the rollers. The claim is to the combination of the two revolving cylinders, with the spring to admit of their receding. The application of the cog gearing as described, and the mode of regulating the velocity by different pairs of wheels fitting on the same centres.

155. For improvements in the *Plough;* Samuel Hartpence and John D. Bowne, Kingwood, Hunterdon county, New Jersey, July 5.

We have repeatedly remarked that after the numerous patents for ploughs, amounting, in this country only, to upwards of two hundred, individual improvement of a striking character ought not to be looked for; but still, those acquainted with the progress of improvement in this instrument are well aware that our ploughs are better in many respects than they were ten years ago.

The claim is all that we shall offer in relationship to the plough mentioned at the head of this article; and, indeed, is as much as is usually necessary. It is to "the manner of constructing the cutter with a screw

bolt above, passing through the beam; and a holdfast, or clip, below, passing through the piece forming the share and point, made in the manner set forth, and holding the whole together substantially as described. Also the placing of a roller upon the rounded part above the cutter, for the purpose of preventing the clogging of the plough."

156. For a *Plough;* John C. Smith, Kingwood, Hunterdon county, New Jersey, July 11.

The claim in this plough is to the "making the share of a rhomboidal figure, beveled and brought to a cutting edge on two of its ends, so that when one edge wears away it can be reversed, or turned end for end, being secured to the sheath by two screws near the centre."

157. For a *Machine for Hatcheling Hemp, &c.;* Phineas G. and Gabriel Rice, Danville, Mercer county, Kentucky, July 11.

A large cylinder set with teeth has four, or any other convenient number, of slats, supported above its upper side, and set with teeth pointing towards the cylinder. A doffing cylinder, set with card teeth, removes the tow from the main cylinder, and it is carried off from the doffer between suitable rollers. The hemp to be hatcheled is fed by hand on a board whence it passes between feed rollers, and is hatcheled between the toothed cylinder and slats; the unhatcheled end being held in the hand. When it has been operated upon sufficiently, the motion of the feed rollers is reversed by the aid of a lever which acts upon a band and pullies in a way to produce this effect; the hatcheled part is thus withdrawn, the motion again reversed, and the other end of the hemp passed in.

It will be perceived that this machine offers but little novelty, and the claim is, therefore, very limited, embracing only "the reversing motion given to the feeding rollers, for the purpose set forth, in combination with a machine for hatcheling, the parts of which are constructed, arranged, and combined substantially in the manner described."

158. For a *Combination Spring and Bolt Sash Fastening;* Philip F. Hazard, Philadelphia, July 11.

The sash fastening described in the specification of this patent resembles very closely such as have been heretofore employed, the main novelty consisting in the employment of a spring sash fastening on one side of the frame, and a permanent bolt on the other; the former of which serves to retain the sash at any height to which it may be raised, and the latter to secure it in its place when it is down. Several modifications of the plan proposed are mentioned, which it would not be interesting to detail. The claim is confined to the combination of the spring and permanent bolts.

159. For an *Apparatus for Colouring Maps;* Lucius Stebbins, Hartford, Hartford county, Connecticut, July 11.

The claim is "to the printing the colours upon maps by means of separate stamps, the surfaces of which are covered with some yielding and absorbent material, and which are cut into the form of the various

divisions to be coloured, and are supplied with colouring matter, and forced against the map, in the manner set forth."

A table is made, the top of which should be of metal, and as large as the map to be coloured. This is divided by partitions raised from it, into cells, or troughs, corresponding with the outlines of the divisions on the map. Each of these troughs contains the proper colouring matter, and a plate fitting it, and covered with cloth to absorb the colour. These plates can be raised simultaneously by a press acting upon stems descending from their under sides, the map being placed above and sustained by suitable means. The plan is intended in particular for school atlases.

---

160. For improvements in the *Apparatus, or Machinery, employed in the Manufacture of White Lead, or Carbonate of Lead;* Charles Ripley, Saugerties, Ulster county, New York, July 11.

The patentee states that "the general principle upon which he proceeds to produce white lead, or carbonate of lead, is by exposing blue, or metallic, lead, in suitable apartments, or chambers, to the action of the vapour of vinegar, or acetic acid, to carbonic acid, and to oxygen gas, at such a temperature produced by steam, as shall best promote the chemical reaction of these agents, so as to produce the substance in question."

The claims made refer to the particular arrangement of the gas and steam pipes, and the mode of governing the supply of the requisite agents in the corroding chambers; all which is fully exemplified by references to drawings.

---

161. For improvements in the *Machine for moulding Candles;* Joseph H. Tuck, Nantucket, Massachusetts, July 11.

"By the use of this machine it is intended to mould a number of candles upon continuous wicks, the moulded candles being drawn from the moulds by suitable apparatus, a fresh supply of wick being at the same time drawn into the moulds, and so on in succession, until seven, eight, or any other convenient number, are moulded upon each wick, which number will be governed by the height of the machine, after which the candles are to be separated from each other." The particular arrangement of the respective parts of this machine is fully explained and represented. The patentee says, "I do not claim to be the inventor of stands of moulds, nor of several other of the individual parts of the machine described; nor do I claim the invention of simultaneously drawing the moulded candles from their moulds by means of a rising frame, this having been previously done, but in a manner differing essentially from that which I have adopted. But what I do claim is the successive moulding of a number of candles upon the same wick without the necessity of separating them from each other until a number have been moulded, in the manner herein described. I also claim the whole arrangement of what I have denominated the sliding shutters, the wick directors, and their appendages, operated upon by sliding frames substantially in the way and for the purpose set forth."

---

162. For a *Serving and Worming Mallet;* John B, Petival, civil engineer, Charleston, South Carolina, July 11.

There have been two or three patents for apparatus for serving and worming ropes for marine purposes, in which the yarn to be employed is wound upon a reel, or bobbin, separate from the worming mallet. That which forms the subject of the present patent consists of a mallet, the head of which is hollow, and contains the bobbin upon which the yarn is to be wound. A groove is made along the mallet, in the usual way, to receive the rope which is to be served, or wormed.

"What I claim as constituting my invention, is the making the head of a worming, or serving, mallet, hollow, so as to receive and contain the bobbin, or bobbins, upon which the yarns are wound which are to be employed in the process of worming, or serving." It is proposed by the patentee to make the head of the mallet of metal, which will leave more room in the interior, and it may be made lighter than those of wood.

---

163. For an improvement in the *Mode of Hanging or Suspending a Band Wheel* in those horse powers in which the band is conducted under the feet of the horse; Isaac Straub, Lewistown, Mifflin county, Pennsylvania, July 11.

The claim is to the sustaining the band wheel, which is horizontal, by means of necks and collars, placed above the wheel, without any step, or bearing, below it. The collars are, of course, attached to the frame work of the machine. This manner of fixing such wheels, for aught that appears, is new, but we do not see the particular advantage to be derived from so hanging them and are apprehensive that friction will not be diminished, or permanence promoted, by this device.

---

164. For improvements in the machine for *making rivets for steam boilers;* and for other purposes; Levi Severance, Pittsburg, Allegheny county, Pennsylvania, July 11.

The arrangement of the gripping, cutting off, and heading, parts of this machine differs from those which have preceded it, and are well contrived. The claims are limited to this particular manner of constructing these parts. We have specimens of rivets, both of iron and of copper made by this machine, and they are perfectly well formed. The most careful among the boiler makers, however, object to the machine-made rivets for iron boilers, on the ground that the iron ought to be of a welding heat for each individual rivet, when made; it being, otherwise, liable to split in riveting, and is brittle when finished.

---

165. For an improvement in the method, or art, of *Carbonating and Smelting Iron Ore;* Asa Whitney, Smithfield, Orange county, New York, July 17.

"I build within the stack of a blast furnace, a cementing chest, or tube, which I can close at the top, and which has an aperture in the bottom through which the prepared ore descends as it melts, into the crucible of the furnace. I surround the said cementing tube, or chest, by spiral flues through which I cause the heat of the furnace to pass." The particular manner of constructing the cementing tube, the flues, and other appendages, is well represented in the drawings accompanying the patent.

"Having good fires in the tubes for heating the air, and the cementing chest nearly full of charcoal, or coke, which is burning out, or slowly

passing down the aperture at the bottom, into the centre, or confluence of the three currents of heated air, in the crucible, I begin to charge the cementing tube with such proportions of ore and fluxes as may be proper for smelting and promoting good separation of the metal from the scoria, with just as much carbon as may be necessary for carbonating the same, and as it settles down I continue to supply more at the top through the feed box, which I close immediately after each charge, until the cementing chest is full, or, to speak more correctly, until the ore and fluxes have descended to the aperture, at which place I expect the ore to be perfectly carbonated, and that it will smelt easily as it passes into the crucible, with good separation of the metal from the scoria; and thus continue working with regular seriatim charges."

"The advantages to be derived from using the before-described furnace are particularly prominent in situations where charcoal is scarce, and other fuel, such as anthracite coal, &c., is abundant; or where ores are abundant and the quantity of charcoal is limited in proportion to the supply of ore."

"What I claim as my invention and discovery, and not before known, is, the building of a cementing oven, or chamber, within the stack of the furnace, and thereby carbonating the ore free from the influence of oxygen, as much as possible; also the form of the crucible, and the application of heat for carbonating and smelting the ore by making the current of air pass in a spiral manner round the cementing chamber up to the smoke chimney."

We have thus given several extracts from the specification of this patent, which are calculated to afford a good general idea of the nature of the thing proposed to be done and of the means by which it was to be accomplished. It will be recollected that the separate carbonating of the ore was proposed in a patent obtained some two years since, by Mr. Boyden, whose plan made much noise for a time, but soon passed from public notice, in consequence of its utter failure. Without pretending to the skill of the practical iron master, we had anticipated such a result from examining Mr. Boyden's specification, as it was apparent, upon the face of it, that the scheme was an untried one, and the means proposed, if carried out, would have been attended with great expense. We believe also, that Mr. Whitney's project has not been carried into operation; he, however, has the reputation of great skill and experience, and we know that it was his determination to test his plan fully; this, we doubt not, would have been done long since but for that state of paralysis which has arrested the voluntary motion, and nearly destroyed the vitality, of all manufacturing and commercial establishments and enterprises.

Without intending to impugn the idea that iron may be carbonated in the smelting furnace, by means analogous to those described, we much doubt the possibility of performing this process upon the unsmelted ore; believing that it is with the reduced iron, and not with the ore, that the carbon combines; and that the ore will be prepared for this combination, in the cementing chamber, only by its being brought to that elevated temperature which will eventually effect its fusion, as it escapes into the crucible. Some may view this question as one of mere theory, but it is important that the true rationale should be understood, as this may lead most directly to a correct practice.

166. For an improvement in the mode of burning fuel in furnaces, by means of a *Suspension Grate;* Thomas Pearson, Monroe Works, Orange county, New York, July 17.

This suspension grate is intended for smelting, and other, furnaces, and is described as being used in Whitney's furnaces, which forms the subject of the last article. The general description of this grate, preceding the references to the drawings, as given in the specification, is as follows:

"I suspend each grate bar by one end, upon a pivot, or general suspension bar, and upon which every bar in the grate is also suspended. The grate bars are inclined, so that the fuel will easily slide, or pass down, them as the fire consumes away, as also will any scoria, or cinder, that may form during the combustion of the fuel. At the bottom of the grate is an inclined stone, dipping towards, and passing under, the bottom ends of the grate bars, down which the slag, or scoria, will flow into the ash-pit. Near the lower ends of the grate bars is a circular bearer which is turned into grooves for the grate bars to rest upon, and by which they are kept at a proper distance from each other. Upon this said circular bearer are as many wrought iron wipers placed firmly as there are spaces between the grate bars, and which arms, or wipers, by turning the bearer round, clear out any slag that may have accumulated at the bottom of the grate bars."

The claim is to the apparatus as above described.

---

167. For machinery for elevating hay into barns, and upon stacks; George Welbur, Macedon, Wayne county, New York, July 17.

A frame is made which consists of horizontal sills resting upon the ground, supporting two vertical timbers, united by suitable cross-ties. This frame is to support an inclined plane which may be twenty eight feet long and six feet wide, with ledges on each side to keep the hay from falling off. There is a windlass attached to the frame, by means of which the elevation of the plane may be altered at pleasure. The hay is to be deposited upon a receiver, at the bottom of the plane, and drawn up by ropes passing around pullies at its upper end; as it is drawn up it is sustained by a rake below it, to which the above named ropes are attached. The claim is to "the combination of an inclined plane with an elevator upon which it is supported and by which its height is regulated, both possessing the characteristics and construction substantially as above set forth."

---

168. For an improvement in the *Floating Dry Dock;* James Barron, Philadelphia, July 17.

This floating dry dock is to have its bottom and sides formed of logs from one to two feet square, laid in tiers lengthwise, and then crosswise, bolted together by wood bolts of from three to four inches in diameter, which, it is said, is double the size of those ordinarily used. The sides are to be double, with a considerable space between them, answering the double purpose of strength and buoyancy; this space being secured against the admission of water. There are gates at one end, as usual in such docks, to admit the vessel to be repaired, and there are the requisite appendages of blocks and shores to sustain the vessel when entered.

The mode of pumping out the water, or rather of discharging it, is a prominent feature of this apparatus. Within the dock there are two boxes which, ordinarily, rest with their bottoms upon the bottom of the floating dock, when one side of each rests also against one of the sloping sides of the dock. These boxes admit the water from the dock into them, through suitable valves, and they are capable of being raised and tilted by means of tackle attached to timbers above them. Towards their inner sides, these boxes are placed at some considerable distance apart, and as their sides recede from each other, being parallel to the outer sides, which slope outwards, they may be tilted towards each other, so as to stand nearly on their inner and lower angles, without interfering; these angles have gudgeons which constitute the joints upon which they tilt. Those gudgeons which are towards the fore part of the dock are hollow, and constitute tubes through which the water in the boxes is to be discharged, valves being fixed at their outer ends to prevent its return. In some cases a siphon is also to be used to aid in the discharge of the water.

The patentee states that by the means proposed, a dock for all merchant purposes can be pumped out by two men in one hour. We have made no calculation on this point, but upon the face of the thing, are apprehensive that this estimate is much too liberal; one thing is certain, that neither by this, or by any other method, can two, or any other number of men, raise more than a given weight of water to a given height in any designated period of time.

The claims are to "the construction and arrangement of the different parts of this dock; in the building it of logs; the method of pumping it out as above described, and also the economical means of connecting the whole mass together by wood bolts double the size of those which can be used in vessels of the ordinary construction." The latter part of this claim we view as altogether untenable, there not being any thing new in the use of pins, or treenails for holding logs together; and as to their size, if there be a dividing line below and above which they are and are not patentable, we should be glad to have it marked out.

A modification of the tilting box is proposed and claimed. This modification will be understood by supposing the two boxes to be united together by their inner sides, so as to constitute a single box divided into two compartments by a partition, with their lower sides uniting in an obtuse angle, which forms the bearing upon which the box may be made to rock from side to side.

---

169. For improvements in the *Plough;* J. B. Norton, Philadelphia, July 17.

The claims made are to "the graduation," which is to a mode of fixing the clevis in any desired position, so as to cant the plough, and increase the width of the furrow, also to "the manner of strengthening and screwing the share to the mouldboard," which though believed to be new so far as the particular means adopted are concerned, does not offer any thing worthy of special notice: a projection formed on the landside for the handle to rest against, and the method of securing the mouldboard to the beam by means of a staple, are likewise claimed.

170. For a machine for *Reducing Thread Waste to the state of Cotton Wool;* Ogden Griswold, Hartford, Hartford county, Connecticut, July 17.

The claim is to "the construction and arrangement of the machine described, in which the waste threads are caught upon hooks, pins, or teeth, on a revolving reel or cylinder, and are whirled round and beaten against the edges of knives, or metal plates, so as to untwist them, and separate their fibres, in the manner set forth."

"The thread waste is placed upon a feeding apron, and is conducted by feeding rollers to a revolving reel, or cylinder, set with hooked teeth, along its projecting bars, or periphery, by which teeth the threads are caught and whirled round with great rapidity. The reel or cylinder is surrounded for more than half its circuit by plates of iron, which I denominate knives, against the edges of which the threads are beaten, causing them to separate into fibres. These knives extend from side to side of the frame of the machine, they are, lengthwise, parallel to the axis of the reel, or cylinder, and widthwise, form an angle of about forty degrees with its radii."

---

171. For an improvement in the *Horse Power;* Levi Rice and Daniel Cogden, West Chester, Chester county, Pennsylvania, July 17.

This horse power is intended for two, or more, horses, to walk in different directions upon a horizontal floor. This floor is to be made of separate pieces of plank of sufficient length for the animal to walk upon. Suppose three horses to be employed, the floor is in this case to be so placed as to form a triangle, each side of which is long enough for a horse path; at each angle there must be a vertical shaft around which the floor is to revolve; a driving pulley is fixed upon each of these shafts, and is scolloped so as to fit into the inner, and curved ends of the planks which constitute the floor. The planks are connected together by joint straps on their flat sides, allowing them to open and close like the joint of a two foot rule, or rather like that of a card table hinge. The floor must be supported upon rollers. It will be seen by the foregoing description that there is much complexity in the affair; a complexity which, we apprehend, will soon condemn it to desuetude. The claim is to "the forming a horizontally revolving floor, with three or more centres, making it in the form of an oblong, triangular, or square figure, for two, three or more horses; and the right of shaping the ends and sides of the planks in any form so that the plurality of centres is preserved in the floor, for the purpose of propelling rail-road cars, thrashing machines, &c."

---

171. For an improvement in the *Horse Power;* Levi Rice, Attleborough, Bucks county, Pennsylvania, July 17.

The claim is this horse power is simply to the manner of using plates and staples to connect the plank of which the endless floor is constituted, and to a variation in the manner of arranging the band of rollers upon which it is sustained; the whole affair is of no great importance, although possessed of some little novelty.

---

173. For an improvement in the method of *Making Soap;* Daniel E. Stillwell, Utica, Oneida county, New York, July 17.

Hard is to be converted into soft soap, by dissolving about eight pounds of common hard soap in four quarts of soft water, heated over a fire, and then adding four ounces of sub-carbonate of soda; the mixture is then suffered to cool, and is ready to use as a convenient and active detergent. The patentee claims the foregoing combination as producing a material suited to become an article of commerce.

---

174. For an improvement in the *Construction of Carriages*; Samuel C. Brown and Levi J. Hicks, Macedon, Wayne county, New York, July 17.

This patent is taken for an improvement in the construction of what is sometimes called the fifth wheel of a carriage, which consists of the apparatus upon which the axle of the fore wheels is sustained, and revolves horizontally, when the carriage is being turned. The claim is to "the use and application of cast iron in the construction of the fifth wheel; in combination with the convexity of the lower wheel; the flanch attached to said lower wheel; the flanch on the upper wheel, and the socket that receives the reach, or perch." These claims it will be seen, refer to certain peculiarities of construction which appear to possess sufficient novelty to justify the grant of a patent.

---

175. For an improvement in the construction of the *Valves for Pumps;* Henry Heckman, Newburg, Cumberland county, Pennsylvania, July 17.

The whole claim to invention in this patent, consists in the forming of the valves for pumps of flat plates, covering the orifice in the seat, and keeping them in their places by two staples, crossing each other at right angles.

---

176. For an improvement in the *Machine for pointing and cutting Wooden Pegs*, for pegging boots and shoes; Joseph Essex, Killingly, Windham county, Connecticut, July 17.

"By means of this machinery, the blocks, after they have been sawed and dressed to the proper thickness for the length of a peg, are first scored in two directions, so that the pegs when cut shall be sharp pointed, and afterwards split in two directions to complete them. The pointing is effected by means of revolving cutters which are fixed upon strips sustained like the rounds of a reel, by means of arms projecting from a revolving shaft." The particular apparatus for moving the block in the operation of pointing, and subsequently in that of splitting, cannot be described without allowing more space to it than the subject will warrant.

The patentee says he does "not claim the scoring, or the pointing of pegs by means of revolving cutters, but the manner of constructing and arranging the revolving cutting apparatus, having the cutters upon adjustable strips, in the manner set forth; also the double platform, the upper portion revolving on the lower, in the manner described."

---

177. For an improvement in *Rotary Stoves*, by adding an oven thereto; Rensellaer D. Granger, Troy, New York, July 17.

The rotary stove upon which the proposed improvement is made, is that usually known as Stanley's. From the centre of the revolving top,

a pipe, furnished with a valve, rises vertically; a second pipe, also, rises vertically from the back part of the stove, clear of the rotary top, and leads, as does the first pipe, into the double case of an oven elevated above the ordinary height of the boilers which occupy the openings in the rotary top. By this arrangement a current of heated air may be directed between the double casing of the oven, whilst the other parts of the stove are continued in use. At the ends of this elevated oven, which may be round or square, there are doors, and within it suitable shelves to receive the articles to be baked.

The claims are to "the conveying the heated air from the fuel through two or more pipes into an oven elevated above the main body of a rotary stove, allowing the boilers to pass under it; and operating substantially upon the principle set forth." There is also proposed to be a swell, or curve, formed on the rotary top, to admit of a larger boiler than usual, when desired, the making of which is likewise claimed."

---

178. For an improved *System of Tailoring;* Amos Sherman, Newark, Essex county, New Jersey, July 17.

The philosophy of the system of tailoring belongs to a class of Savans into whose school we have never been admitted; but we apprehend from the various reports of "Mathematical," "Standard," "Geometrical," and numerous other instruments for ascertaining the human contour and dimensions, that this department of science must be brought as nearly to perfection as are our terrestrial admeasurements by triangulation, or our knowledge of the longitude by the aid of chronometers, lunar observations, and the eclipses of the satellites of Jupiter. If we are mistaken in this conjecture, it belongs not to common minds to detect the error; and should a garment be now and then spoilt, this will no more prove that the philosophy of tailoring is not perfectly understood, than the use of a wrong exponent by the mathematician would prove that his science was incorrect.

In those departments of knowledge which are the most advanced, great discoveries are scarcely to be hoped for, but still every thing is progressive, and we should set a due value upon every step made towards absolute perfection, however short it may be, or however modest the terms in which it may be announced. After these preliminary remarks, we offer the following summary of the improvements now presented to us, which is in the following words: "The invention claimed by me, the said Amos Sherman, and which I desire to secure by Letters Patent, consists in the before-described method of taking measure, and cutting clothes; also the addition of the projection, or blade, to the square, and attaching the tape to the hook E, of the blades, as described."

---

179. For an improvement in *White Paint;* Forrest Shepherd, New Haven, Connecticut. First issued March 18th, 1835; surrendered and reissued, July 17. (See Specification.)

---

180. For an improved *Water Colour Paint*; Forrest Shepherd, New Haven, Connecticut, July 17th. (See Specification.)

181. For an improvement in the mode of *Applying Horse, or other Animal Power, to Propelling Machinery;* Barnabas Langdon, Troy, New York, July 19.

We have not here a perpetual motio n, or any thing which actually sins against the laws of mechanics; still we are very apprehensive, that the patentee, who manifestly believes that he has devised an advantageous mode of communicating the motive power of animals to machinery, will eventually discover that he has been treading in a circuitous path, whilst he might, at less expense of time and labour, have gone directly up to his object by one of the more common and direct roads.

The horse, or horses, employed are to walk in a circle, and to draw by levers attached to a vertical shaft, in the manner well known. The machine as represented is for four horses, there being four arms or levers extending from the vertical shaft. Within the horse track there is to be a circular rail way, and upon this rest four wheels, each having for its axis one of the horizontal shafts above named. A circular platform, which may be equal in diameter to the circular railway, rests upon the tops of these wheels, and in order to produce the necessary adhesion, weights to any desired amount may be placed upon it. From this platform, motion may be communicated to machinery by affixing a cog-wheel on its upper side, with a pinion on a horizontal shaft working into it by bevil gear. This is the sum and substance of the machine, the description of which closes with the subjoined formidable claim.

"What I claim of the improvement thus above described, is the manner in which the circular flat rim, or platform, is made to revolve horizontally in its own circle by means of the progressive motion of three or more rollers, or wheels, rolling round a common centre upon a circular track, or railway, under the propulsion of horse, or other animal power, with the rim or platform placed on the top of the rollers and being supported and carried round by them; and the manner of accelerating its motion by means of longer wheels to be fixed by the side of such railway rollers upon the same shaft; and also the manner of communicating the power and effect of the momentum of the rim or platform, thus acquired, to other wheels, by the intervention of cogs, bands, or other means in common use, for the purpose of obtaining rotary movements for mechanical, manufacturing, or other practical purposes, as above described, together with the provision for adding weights as an overload for increasing the momentum, or friction, of, or between, any of the revolving bodies in connexion, as may be required; and also the principles embraced by the said improvements so far as the same are applicable to machines of the above description."

---

182. For a sounding instrument for *Ascertaining the depth of Water in Seas, Rivers, &c.;* Francis B. Ogden, of New Jersey, and John Ericsson, of Sweeden, July 19.

This instrument is intended to ascertain with accuracy the depth of water, or soundings, from a ship or vessel, when, by reason of currents, the rapidity of the vessel's way through the water, or other causes, it cannot be determined in the usual manner by the lead-line." "The invention consists in ascertaining the depth by means of the pressure of the water, which at given depths is always nearly alike, the water being allowed to enter the instrument and made to compress a certain quantity of atmospheric air contained therein, and to overflow the orifice of a small

tube, into a glass tube, or recipient, in which it will rise in proportion to the superincumbent pressure, and thereby indicate the depth to which the instrument may be lowered." The claim made is to an instrument so constructed as to operate in the manner above indicated. The particular construction of such an instrument may admit of some variation, but the general principle upon which it operates will, we think, be sufficiently apparent.

---

183. For an improved construction of *Grates and Fire Places;* Ellison Conger. Newark, New Jersey, July 22.

"The nature of my invention consists in supporting the coal upon a hearth, and making the flue at, or near, the bottom; thereby obtaining a horizontal draught of air through the fire, either direct or laterally." One of the figures in the drawing represents an open, or Franklin stove, with its hearth as usual, but having an opening for the flue just above the level of the back of the hearth; this flue leads into what is denominated a heat chamber, behind the fire, which, though it differs from heat chambers previously constructed sufficiently to give it some claim to novelty, it is not thought necessary to describe particularly. The other figures show the manner of conducting the horizontal draught through fires in grates in ordinary fire places. The claims made are to the particular manner of arranging the hearth and flue to obtain the horizontal draught; to the manner of making a sifter, and to the heat chamber as described.

---

184. For an improved *Cooking Stove;* Abraham T. Mixsell, Belvidere, New Jersey, July 19.

The claim made is to "the construction and arrangement of the flues as described; and the apertures to admit or exclude the air at the sides of the stove, so that the fuel may be consumed under the hindermost boilers only, when this may be desired." To describe the peculiar arrangement of the flues and valves in stoves in all their varying combinations, would be no easy task, and there are few to whom it would be acceptable, if performed; in many cases the novelty would be small, and the utility questionable, and to be determined by the test of experiment only; and that frequently in one way by the purchaser, and in another by the inventor. There is more *novelty* in the form and arrangement of the valves and flues of the stove before us, than is usually found in these parts, but the reality of the *improvement* is not equally manifest.

---

185. For an improved *Stove for Cooking and Heating;* William B. Kimball, Peterborough, New Hampshire, July 19.

In this stove there is a hearth at the lower part, with an opening, similar to that of the Franklin stove, in which wood may be burnt in the usual way; and above this there is an enclosed fire place, in which coal, or other fuel, may be employed, the grate bars standing immediately over the open fire place. There are flues and valves so arranged as to govern and direct the heat under cooking utensils, and around an oven situated at the back of the stove, which appear well calculated to answer the purpose intended. The claims made are to "the particular manner in which the double stoves are conbined with the flues or passages, valves, dampers, or shutters, with each other, as described; not

claiming either or any of these parts taken individually, or in the connexion of one individual part with another, but claiming that arrangement of the respective parts with each other, as a whole, so as to constitute a stove substantially the same with that set forth."

---

186. For improved *Self Adjusting Temples for Looms;* Samuel P. Mason, Newport, Rhode Island, July 22.

These temples are in their general construction very similar to others previously in use, the difference being in the arrangement of the parts by which the jaws are opened. The claim is to "the manner in which the stationary inclined plane and forceps are placed on the plate of iron; the manner in which the forceps are opened by being forced on said stationary inclined plane when assisted by the lathe, and are thrown off the inclined plane when the lathe recedes."

---

187. For an improvement in the manufacture of *Stoves for burning Anthracite;* Jordan L. Mott, city of New York, July 22.

This is intended to be an economical stove for the burning of, and cooking by means of, anthracite. It differs but little in form from such as have been before made from plates cast separately and put together in the usual manner. It is, in fact, a small open stove with a feeder for the supply of coal, and an opening for a kettle or other cooking utensil, and is intended for summer use. The claim is to "the casting the whole body of such a stove and its feeder, with the exception of the top and bottom, or in some cases conjoined with the bottom, in one entire piece."

---

188. For improvements in the mode of *Constructing Railroads;* Isaac Cooper, Johnstown, Cambria county, Pennsylvania, July 22. (See specification.)

---

189. For improvements in the mode of constructing and connecting together, the *Cars and Carriages used on Rail, and other Roads;* Robert Grant, Philadelphia, July 22.

"My first improvement consists in a mode of constructing the wheels and axles of cars or carriages, and their appendages, by which the draught is applied to a wheel which rolls within a rim upon a larger wheel near to its periphery, the tread of which larger wheel bears upon the rail or road. I am aware that this principle has been already applied, or has been proposed to be applied, to the wheels of cars and carriages, but by an arrangement differing essentially from that which I have adopted."

This plan of making a smaller wheel within the periphery of a larger drum, or wheel, has been made the subject of a patent in England, and was spoken of as a plan for enabling a car, or carriage, to carry its own railroad. The whole plan appears specious, but, hitherto, it has proved fallacious; and although the present patentee has manifested considerable ingenuity in the particular arrangements made by him, the structure is thereby somewhat more complicated, without the introduction of any thing apparently calculated to remove the objections to the general plan; we believe, indeed, that these objections are radical.

The second improvement proposed, is in the mode of constructing or

coupling trains of cars together by means of a double hinge joint. The claims are to "the manner of connecting the larger wheels by means of revolving tubes which constitute their axes, and allow the axle of the interior wheels to pass through and revolve within them in the manner described. Also the enclosing of the interior wheels by means of a face plate, and the combining therewith a central circular plate admitting the axles of the interior wheels to pass through them as set forth. Also the manner of combining the solid and tubular axles, either of the interior wheels, or of the ordinary wheels of railroad cars. Also the double, or greater number, of vertical hinge joints for connecting trains of cars together. Also the so placing of the middle rail of the frame of a car as that it shall aid in supporting it in case of the breaking of an axle, substantially as set forth."

---

190. For improvements in the construction of a *Self Sharpening Plough;* Isaac Snider, Mount Pleasant, Westmoreland county, Pennsylvania, July 29.

The claims in this plough are to some small differences from the usual manner of attaching the parts of the plough together, not appearing to require any particular notice.

---

191. For improvements in the *Machine for Planing Mouldings on Wood;* Ambrose Church, Jr., Canandaigua, New York, July 29.

This machine is for sticking mouldings by means of a moulding plane made to traverse back and forth, by a crank motion, in a manner frequently adopted. The claims are to certain particular devices and modes of arrangement, intended to produce accuracy in the result, and to facilitate the operation, in a way which cannot be shown without the drawings.

---

192. For improvements in *Fire Arms;* Henry Harrington, Southbridge, Worcester county, Massachusetts, July 29.

The barrel of this gun is to consist of a great number of small tubes, which may be of a proper size for shot; it may be made by soldering these tubes within an ordinary barrel, extending its whole length. At the breech end of the barrel there is to be a mortice to receive a box or chamber, which is to be charged with the shot and powder. The end of this chamber which bears against the barrel is to be covered with a plate perforated with holes which coincide with those in the barrel; these holes are to be somewhat conical, the larger ends being towards the barrel. Shot are to be inserted in each of these holes, and pressed in by the finger; the chamber behind them is then to be filled with powder, and the box inserted in its place, when it may be discharged by means of a percussion cap. The same arrangement is proposed for cannon, and for pistols. The claim is to "the throwing of shot or balls from any number of barrels united together, by exploding powder in a single chamber, substantially in the manner above described." The patentee sets forth the advantages which he anticipates from a gun made in this way; we think, however, that were the disadvantages also to be enumerated, the positive terms would disappear, and there would remain a minus quantity.

193. For a *Process for purifying Salt Water preparatory to manufacturing Salt;* Nils Sholtewskii Van Schoultz, Saline, New York, July 29. (See specification.)

---

194. For improvements in the machine for *Spinning Woolen Roving;* Edgar M. Titcomb, Andrews, Essex county, Massachusetts, July 29.

"The nature of this invention consists in passing the woolen roving between the opposite sides of an endless belt, while the sides of the belt are pressed into contact with the thread of the roving. While the thread passes between the opposite sides of the endless belt at right angles to those sides, the belt is in rapid motion over and under two rollers, and those opposite sides of the belt moving necessarily in opposite directions, and being in contact with the thread, twist the roving, and prevent its being broken as it is drawn out to greater length and fineness." The claim is to "the application of the endless belt, so as to twist the thread of the woolen roving on its passage from the back to the front rollers."

---

195. For an improvement in the *Machinery for making Horse Shoes;* B. Young and S. Tistus, Brooklyn, Windham county, Connecticut, July 29.

"What we claim, therefore, is the manner of forming the shoe by the combined operation of the rollers, the guides, the conductor, and the die, arranged and constructed substantially in the manner herein set forth." The shoes, it will be seen, are to be formed, in part, by rollers, but the doing this is disclaimed as not being in itself new; the accessory parts, as represented in the drawings, manifest considerable skill, but whether they remove the difficulties heretofore experienced in making horse shoes by rollers, is a practical question, to be answered only by the machine itself, and we are not informed respecting what character it has established and sustained.

Specifications of American Patents.

Specification of a patent for an improvement in White Paint, for which letters patent were granted to Forrest Shepherd, *on the 18th day of March, 1835. Which letters patent were canceled, and reissued upon the following amended Specification, July* 17, 1837.

To all whom it may concern: Be it known, that I, Forrest Shepherd, formerly of Fredericksburg, in the county of Spottsylvania, and state of Virginia, but now of New Haven, in the county of New Haven, and State of Connecticut, have invented a new and useful preparation of white paint, to be used in combination with oil, in the same way in which white lead is now used; and I do hereby declare that the following is a full and exact description thereof.

I take the mineral known by the name of sulphate of barytes, barytes, or terra ponderosa, and reduce it to a fine powder, after which, I mix it intimately with oil, and, if necessary, again grind it, in the same way in which paint is usually ground.

With this paint as a basis, any of the pigments now used with other kinds of white paint, may be incorporated, and any desired tint, or shade of colour be thereby produced.

What I claim as my invention, or discovery, and wish to secure by letters patent, is the employment of the mineral, or native, sulphate of barytes, properly incorporated with oil, as a white paint, or as a basis with which various pigments may be used in the process of painting.

FORREST SHEPHERD.

Specification of a patent for an improved Water Colour Paint; Granted to FORREST SHEPHERD, *New Haven, Connecticut, July* 17, 1837.

To all whom it may concern: Be it known, that I, Forrest Shepherd, of New Haven, in the county of New Haven, and State of Connecticut, have invented, or discovered, a new manufacture of white water colour paint, using as the basis thereof the mineral known under the name of sulphate of barytes, by means of which a beautiful and perfectly opaque white is obtained; and I do hereby declare, that the following is a full and exact description thereof.

Instead of using oil with the barytes, as described by me in the specification attached to letters patent of the United States, dated the eighteenth day of March, in the year 1835, for "a composition to be used as a white paint;" I take the same mineral, sulphate of barytes, in its native state, and reduce it to an impalpable powder, and I then mix it with water in which there is a sufficient quantity of gum tracacanth, gum Arabic, or other adhesive gum miscible with water, or any other fluid not oleaginous, and adapted to give adhesiveness, or a binding quality, to the pulverized mineral. The composition may, if necessary, be again ground after mixture. This I lay on as water paint, and when properly prepared, it is of a clear white colour, and perfectly opaque. The paint thus prepared, adheres very firmly to wood, &c., and for various purposes will be found extremely useful, especially when it is not exposed to the vicissitudes of the weather; and in situations where it is so exposed, it may be rendered permanent by a coating of good clear oil, or spirit varnish. Various tints and shades of colour may also be given to it by a proper admixture of any suitable pigment, as in the case of the oil paint. This water paint may also be very advantageously applied as a ground coat upon work which is afterwards to be covered by the oil paint.

I am aware that the artificial, or factitious, sulphate of barytes has been used as a water colour by miniature painters, and in other delicate works; but the application of the mineral, or natural, sulphate, as a water colour, is, as I believe, new, and of my invention, or discovery. What I now claim, therefore, and desire to secure by letters patent, is the employment of the natural, or mineral, sulphate of barytes, as a water colour, or paint, whatever aqueous fluid may be preferred as its vehicle, and whatever gummy or tenacious material, or pigment, may be mixed therewith.

FORREST SHEPHERD.

Specification of a patent for improvements in the mode of constructing railroads; granted to Isaac Cooper, Johnstown, Cambria county, Pennsylvania, July 22nd, 1837.

To all whom it it may concern, be it known, that I, Isaac Cooper, of Johnstown, in the county of Cambria, and State of Pennsylvania, have made certain new and useful improvements in the manner of constructing railroads, and I do hereby declare that the following is a full and exact description thereof.

My improvement consists, in part, in the form which I give to the upper sides of the string pieces upon which the rails, chairs, or plates, are to be sustained, or to the upper sides of the block of wood, or of stone, used for the same purpose; in the form and construction of the chairs adapted thereto, and in the manner of combining and connecting the respective parts together, so as to form a more stable foundation and superstructure than have hitherto been obtained at the same cost.

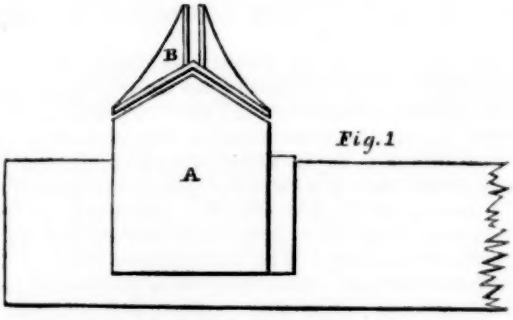
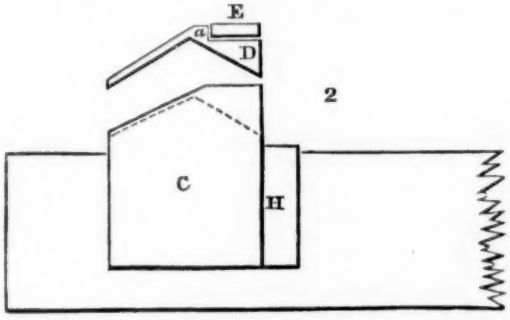


Fig. 1

I sometimes make my rails by taking string pieces of a peculiar form on their upper sides, and upon these I put edge rails, by means of chairs adapted to the form of such string pieces. Fig. 1, in the accompanying drawing, shows a cross section A, of one of the string pieces of timber, and a side view, B, of a chair adapted thereto. These string pieces may be of any convenient length and size, but it will be found best to make them larger than those ordinarily used? Twelve inches in height and two in thickness, I should prefer. It will be seen by the section that the string piece is made ridge-shaped on the top; the angle formed by the sloping sides may vary considerably, but a descent of two inches and a half on each side will answer all the purposes intended. Instead of descending from the ridge, or middle part, in a straight line, it may do so in one which is somewhat concave, or convex; the chair, in this case, being adapted thereto. The same remark will apply to the blocks of wood, or stone, hereafter to be described. The chair B, is so formed on its under side as to adapt it to the ridge-formed string piece across which it is made to straddle. Such chair, so formed, and firmly attached to string pieces, will afford greater stability, being less liable to displacement, and resisting the lateral thrust more effectually than any mode of forming and fixing such articles, now in use.

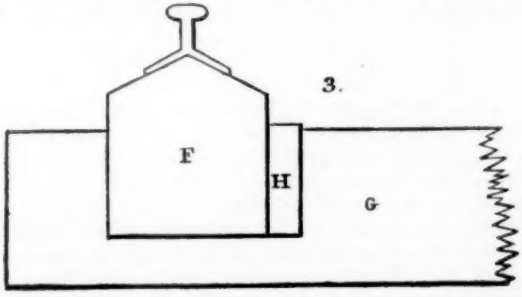
When it is desired to use a plate rail, the top of the string-piece must be adapted thereto. In fig 2, is shown a section of such a rail

and plate, together with the kind of chair which I have invented, and adapted to be used with rails of that description. The upper sides of the string pieces are, in this kind of rail, sloped towards the outer edge only, commencing from a point immediately under the outer edge of the iron rail plate; C, in this fig. is the section of the string piece, D, the chair, and E, the rail plate. The chair is made in the form shewn in the drawing. The chair is to be let into the string piece, so that its top shall be flush with the top thereof. There is a shoulder, offset, or jog, at *a*, to steady the rail plate; this shoulder may be extended up within an eighth of an inch of the surface of the plate. These chairs I make of cast-iron of such strength as is necessary to sustain the load; they, however, will be found but little liable to fracture when properly imbedded in the rail. The distance of these chairs from each other may vary from eighteen inches to three feet.



The dotted line shows the depth to which the chair may be let in to the string-piece.

Fig. 3, represents a cross section of a rail-road, and exhibits an improved mode of construction, in which the rail, or the chair which supports it, is placed upon blocks of wood, or of stone, having the upper



surfaces of such blocks ridge-formed, in the same way with the string pieces first described. F, are blocks of stone, or of wood, the upper sides of which are ridged-shaped, and their lower let into the cross tie-piece, G, and secured there by means of wedges, H. The tie pieces may vary in size, but abundant strength is a point of much importance: I contemplate having them, usually, about eight feet long, fourteen inches broad, and eight inches thick, and then make the notches to re-

ceive the blocks four inches deep. The rail may be made so as to be used without chairs, in which case its form will be somewhat like that of the T rail, the lower side, however, being rolled in such a shape as to adapt it to the ridge of the block, upon which shape its stability will greatly depend. Edge rails of any of the ordinary forms may be used by employing chairs adapted to them, and to the ridge-formed block. In a road so constructed a stone block foundation will possess the requisite elasticity, from its resting upon the wooden tie piece. If preferred, a similar advantage may be obtained by imbedding the stone blocks on a rubble foundation in the usual way, leaving their upper surfaces flat, and securing the tie pieces above instead of below them. The ends of the tie pieces are, in this case, to be notched, or cut, into such a form as to adapt them to the kind of chair, or rail, above described, that is to say, they must, when these are seated upon them, be ridge-formed.

What I claim as constituting my improvements in the mode of constructing rail-roads, is the giving to the upper sides of the string pieces, blocks, or cross-ties, the ridged form, as herein set forth, for the purpose of receiving chairs, or rails, adapted thereto on their under sides. I also claim the forming of the string pieces with a slope or chamfer, along one side of their upper surfaces, when plate rails are used, and the construction and application of chairs, such as are herein described, to the fixing and sustaining of the rail plates, by which means the plate is enabled to resist the lateral pressure to which it is subjected; and the great strain upon the spikes, and the indentation of the timber, are obviated. I likewise claim the application of cross ties of wood, either below, or above the blocks of stone, or of wood, which make a part of the foundation of a rail-road, in the manner, and for the purpose, fully made known in the foregoing specification.

ISAAC COOPER.

Specification of a Patent for a process for purifying Salt-water, preparatory to manufacturing Salt; granted to NILS SHOLTEWSKII VAN SCHOULTZ, *Salina, Onondaga county, New York, July 23rd,* 1837.

To all whom it may concern be it known, that I, Nils Sholtewskii Van Schoultz, of Salina, in the county of Onondaga, and State of New York, have invented a new and useful mode of purifying salt water, used for the manufacturing of fine and coarse *salt*, and I do hereby declare that the following is a full and exact description thereof.

The nature of my invention and discovery consists in decomposing the impurities kept in solution by the salt water, which impurities chiefly consist of muriate of magnesia, sulphate of magnesia, muriate of lime, sulphate of lime, sulphate of soda, carbonate of iron, iodine and a bituminous oil, &c. &c.; this decomposition is performed, before the salt water is drawn into the kettles, or pans, in the ordinary wooden cisterns belonging to the salt works, if said cisterns are of such dimensions that they contain sufficient water for twenty four hours consumption in the respective works. But as the impurities must have time to sink to the bottoms of the cisterns, before passing into the kettles, or pans, three cisterns, at least, must be attached to each saltwork, each cistern

containing water enough for twenty four hours' boiling, thus permitting the water to settle during forty eight hours.

To enable others skilled in the art to use my invention, or discovery, I will proceed to describe the operation; first remarking, however, that salt waters contained in different wells, differ from each other in their composition, wherefore a different method for purifying the salt water in one class of wells must be used, when compared with the method of purifying the water drawn from the second class of wells.

Salt wells may be divided into two classes. In *the first class*, the impurities consisting of sulphate of lime and carbonate of lime predominate; and the salt manufactured out of that water will be highly impure, by containing the two above named impurities; more or less, in proportion to what the water held in solution before the evaporation. In the *second class*, the impurities consisting of muriate of magnesia and muriate of lime predominate, and the salt manufactured out of that water will not only be impure by containing these two substances, but will never dry in consequence of the two deliquescent salts which continually absorb water from the atmosphere, whereby a continual draining is occasioned, with a consequent loss of salt.

The salt wells at Onondaga, in the State of New York, belong to the first class; the salt wells at Kanhawa, in the State of Virginia, belong to the second class.

For purifying the salt well-water of the *first class*, or where sulphate and carbonate of lime predominate, I take the following method.

For a wooden cistern containing six hundred cubic feet of water, I throw in fifty bushels of charcoal (or mineral coal, if attention is paid to the quantity of carbon contained in the said mineral coal;) then I fill the cistern with the salt-water; when full, *one pound and two ounces* of alum is thrown in and the water is well stirred; then left to settle during forty-eight hours, after which time it is fit for use.

For purifying the salt well-water of the *second class*, or where muriate of magnesia and muriate of lime predominate, I take the following method.

For a wooden cistern containing five thousand cubic feet of water, I throw in one hundred bushels of mineral coal; then I begin to fill the cistern; when half full, I throw into the water one sixteenth part of a bushel of *quick lime* and stir the water; when the cistern is full, *three* pounds of alum are thrown in, the water stirred and left to settle during forty eight hours, after which time it is fit for use. The lime is here used for the decomposition of the muriate of magnesia, precipitating the magnesia and forming with the muriatic acid muriate of lime, which latter is decomposed by the influence of the coal and alum. The lime must first be thrown in and then the alum, because if the order is reversed the lime would act on the alum and decompose it.

To use lime for the purifying of salt well-water, belonging to the first class, for instance at Onondaga in the State of New York, would not only be useless, but hurtful; inasmuch as the lime, decomposing none of the impurities, would be found in the salt.

The above mentioned quantity of coal will be sufficient for a month, but the other substances, alum and lime, must be used every time a cistern is filled.

When the presence of *Iodine* is so great that it corrodes the vessels, I use one fourth part of an ounce of *sulphate of manganese*, which, enveloped in paper, is thrown into the cistern, and is to be renewed every fourteenth day.

What I claim as my mode and discovery, and desire to secure by Letters Patent, is the united effect of *carbon*, *alum*, and *lime*, and *sulphate of Manganese* in the salt well-water, for the purpose of purifying said waters, for the use of manufacturing salt.

N. Sholtewskii Von Schoultz.

Progress of Physical Science.

On the formation of Hail. By M. De la Rive.

(Continued from page 209.)

After having remarked the direction of the storm, and rested for a moment from my fatigue and alarm, I reached the Puy-du-Dôme, a magnificent observatory, where I was still near the clouds. It was now two o'clock, and the state of the skies made me fear other heavy showers, which I was solicitous of avoiding. I then directed my steps towards the Puy-des-Goules, between two and three miles from the top of Puy-du-Dôme, and I ascended it about three o'clock. The heavens were very much in the same state, the two strata of clouds were still apparent, and the south wind, which was very cold, scudded with great strength along the sides of the mountain. It brought along with it another hail-cloud, which appeared to be heavily charged, and in which I was enveloped for about five minutes. The hailstones were numerous, and the largest was scarcely the size of a filbert. They were formed of concentric layers, more or less transparent, and were roundish or slightly oval; they were all carried along in a horizontal direction with great velocity, from which the attraction of the mountain seemed to make them swerve, and many fell upon its sides. Very many struck me without doing me any injury, and they fell as soon as they touched me. The greater part of the cloud passed over my head, and I distinctly heard the hissing noise of the hailstones, or rather a confused noise, the result of an infinite number of partial sounds, which I could attribute to nothing else than the friction of each hailstone against the air. The cloud which passed over my head, and in which all the hail was formed, allowed none to escape beyond half a league from the spot on which I was standing. Some, however, fell on the northern side of the mountain which intercepted its progress, and I collected a certain number of the hailstones in a phial. I subsequently submitted the water to many chemical tests, and I obtained a sensible precipitate, with nitrate of silver and muriate of barytes.

All the hailstones appeared to be subjected to a very rapid rotary motion, but in different directions, so far as I could judge by examining their movements at the moment of their fall on the crown of my hat, which I held as much horizontal as possible to receive them. Many other clouds, charged with hail, still rose from the south, and now on one point, and now on another, it hailed without interruption from one till four o'clock on the chain of the Puys, from Mont Dore, as far as Riom and Volvic.

Between four and five o'clock the hail ceased; the clouds now formed only a single stratum, but they often presented that phenomenon I had noticed in the morning, viz: that they grouped together, and then poured out, along with flashes of lightning, enormous quantities of water. The south wind also had now ceased, the west alone blew, and carried along with it these frightful waterfalls. One of them discharged itself in my view at Barraque, on the great road to Clermont. I was distant from it about forty yards, and not a drop of water fell on me. A heavily loaded carriage which was at a little distance, disappeared in the twinkling of an eye, under the mass of water which the heavens poured down upon it. After the passage of the water-spout, it was overturned in a ditch, and the postilions, for a time, did not try to right it, so intense was the darkness in the midst of the storm. Large pieces of pavement and great blocks of granite were carried along by this waterspout, which still hurried away before me, and reached Clermont half an hour before I could arrive. The storm on the second of August was not so rapid in its progress as that of the 28th of July, and it traversed a much shorter line. It began upon the mountains of Cantal, and terminated upon the confines of Auvergne and Bourbonnais. M. L. de Bunch, who, that day, was at Cantal, ineffectually attempted, at ten in the morning, to reach the summit of Puy-Griou, on account of the violence of the wind. My brother-in-law M. Nivet, who was at the Mont Dore, did not perceive the wind at the Pic de Sancy till midday, and I myself, upon the top of Puy-du-Dome, did not perceive its violence till one o'clock, and it was then only that the hail clouds arrived.

Perhaps I may have dwelt somewhat too much in detail upon these phenomena of which I was an eye witness, but I believe I have collected some facts which are new to meteorology, a science which is not very rich in them even at the present day. I shall conclude by endeavouring to sum up, without, however, considering them as quite general, the observations which I have collected on the two occasions I have specified.

Conclusions.

1st. It appears that hail is formed during the prevalence of winds of *impulsion*, and not of those of *inspiration*, which, however, are generally more violent than the former. The storm of the 13th July, 1788, concerning which M. Tassier made a report to *L'Academie des Sciences*, goes to confirm this opinion. Its velocity was nearly the same as that of July 28, 1835.

2d, Two strata of clouds, placed the one over the other, and two winds from different quarters, seem necessary for the production of hail.

3d, The hailstones do not pass from one cloud to another as Volta supposed; on the contrary, they advance with very great horizontal rapidity, and are urged forward by an extremely cold wind.

4th, Electricity nevertheless plays an important part in these phenomena, and, according to all appearance, the superior cloud supports the inferior, heavily loaded with hailstones, and probably in a state of opposite electricity. There is probably also electrical repulsion among the hailstones which form the anterior extremity of the cloud, and which there present the whirlwind-like phenomenon which is so remarkable, and which I have twice observed in the most distinct manner

5th, The hailstones do not strike against each other during their horizontal transport; and the noise which is heard, that rolling murmuring which is perceived at so great a distance, is owing to the combination of the individual sounds produced by each hailstone cutting the air with such swiftness. The clashing of any hailstones during their progress causes them immediately to descend.

6th, We are led to suppose that the hailstones are subjected to a rapid rotary motion, but my opportunities have not yet enabled me distinctly to see it.

7th, The formation of hailstones, and their increase, appear to be owing to cold produced by the evaporation at their surface, on account of their great velocity. The hot air into which the anterior edge of the cloud penetrates, leaves a portion of water deposited upon them, a part of which is evaporated, and thereby congeals the other part, and thus forms concentric layers round the nucleus; the wind unceasingly transports the hailstones into new portions of the air which is saturated with moisture, and the upper cloud supports them in their progress. But the lower cloud rapidly increasing in density, by degrees falls down, and separates itself, more especially on its anterior portion, from the electrical cloud which supports it, till it reaches that point in which the action of this latter is almost nothing. the hailstones being all electrified in the same manner then strongly repel each other, and present that violent agitation which is perceived at the surface of the earth, and which repels in all directions those hailstones which the wind reunites by imposing upon them its own direction.

8th, The presence of long crystals at the opposite poles of the hailstones of the 28th July, 1835, would indicate that those which were placed at the equator were destroyed during their descent by the rotary motion, or that this same movement hindered them from being formed upon the equatorial portion on account of their velocity, whilst they were easily grouped upon the poles.

9th. The water procured from the melting of the hailstones was far from being pure.

From this short review, we may see how necessary it is, especially in meteorology, to guard against too readily generalizing facts. We must first observe, and then observe again, and we must wait till favourable occasions again place us in circumstances where we may see well, and study well, before we propose theories which, like those of Volta, can be supported only upon the reputation of a great name.

Clermont, 1*st February.*

The account which we have just been reading, and the precise results which the author deduces from the facts of which he was an eye witness, appear to be of a nature calculated to throw much light on the still rather obscure subject—the formation of hail. As, moreover, they seem to agree with the view we have taken with regard to this phenomenon, we may be allowed, in concluding this article, to explain briefly the opinions which we have formed on the point.

Electricity, then, always accompanies the formation and fall of hail; but we are often asked if, in correct reasoning, this is a sufficient motive or admitting that the hail owes its existence directly or indirectly to the lectricity:—Is it not possible that the same cause which determines

the formation of the hail, at the same time developes the electricity, and that these two phenomena, instead of being connected as cause and effect, have no other alliance than that which depends on their having a common cause? The new opinions upon electricity with which science has within these few years been enriched, and more especially those which have obtained concerning the different circumstances in which this element may be developed, seem to confirm this conjecture; they seem also to derive a new degree of strength from the observations which have been made by M. Lecoq, and we shall therefore endeavour to develop our views.

The propagation of heat in any body is always accompanied by a development of electricity; and so far as there is any difference of temperature between the different parts of a body, so far is there a rupture of the natural electrical equilibrium. Now, if we consider a vertical column of atmospheric air during a serene calm, when no wind or cloud affects its physical condition, it will represent a body in which the temperature goes on decreasing from the base, which rests upon the earth, to its summit, which is the limit of our atmosphere. The difference of the temperature at the two extremes of this column must be very considerable, since it is admitted that the temperature of the atmosphere at its upper limit is at least —50° Cent. This difference ought also to be greater in summer than in winter, and in hot than in cold countries, since the temperature of the base of the column of air is determined by that of the soil upon which it reposes, whilst the temperature of its summit, being that of the limit of the atmosphere, is every where and at all times the same. This difference of temperature, which extends itself uniformly between all the points of the vertical mass of air, is necessarily the result of a continual propagation of heat from below upwards, and should consequently be accompanied by a development of electricity, the intensity of which should be increased in proportion as it ascends, that is to say, in proportion as the difference of temperature becomes greater. Now this is precisely what we learn from direct observation; we in truth find that the atmosphere, when it is calm and serene, is charged with a positive electricity, whose intensity is continually greater as we ascend. As to the negative electricity, which should accumulate at the base of the column, it is absorbed by the earth; for many observations of various kinds, and amongst others those of De Saussure and of Volta, demonstate that the earth is endowed with a negative electricity.

Taking, then, this view of the matter, which reposes solely upon experiment, and perfectly accords with what we discover in a body heated at one of its extremities, the permanent electrical condition of the atmosphere will essentially depend on the manner in which the heat is distributed, and propagates itself throughout the air, and not upon evaporation, vegetation, or any other cause variable in intensity, and unequally distributed, to which the atmospheric electricity has been erroneously, as we think, attributed. It would be easy to demonstrate that this explanation can account with the greatest accuracy for the variations which atmospheric electricity undergoes; and in particular that it is not in opposition to the fact observed by M. De Saussure, and after him by other naturalists, that this electricity is stronger in winter than in summer. In truth, the greater intensity of atmospheric electricity

during the winter is owing to this circumstance, that the electroscope, by means of which we perceive it, is at this period of the year put into communication with a larger portion of the atmosphere, on account of the moisture with which the air is then almost always saturated.

Should the atmosphere cease to be serene, or should a mass of air loaded with humidity, and carried by the wind, happen, by its mixture with another mass of air, to produce clouds, immediately a new distribution of temperature, and consequently of the electrical condition of the column of air, would be effected. To comprehend this result, we must remember that the solar rays which heat the surface of the earth traverse the atmosphere without sensibly heating it; and that it is the heat emanating from the earth which essentially determines the calorific state of the atmosphere. Now when a vertical column of atmospheric air is divided into two sections by a layer of vapours, or by a cloud more or less thick, the terrestrial heat, not being able, at least wholly, to traverse this layer or this thick cloud, is sent back towards the earth whence it came, instead of penetrating through and beyond it. The portion of the column comprehended between the cloud and the soil preserves, therefore, this heat, whilst the portion included between the cloud and the limit of the atmosphere receives little or no heat; and the more the former of these two portions becomes hot, the more the second must be cold. Thus the column, instead of exhibiting a gradual decrease of temperature from its base to its summit, is found to be divided into two portions, having each a uniform, but very different, temperature. The cloud, more or less thick (or there may be many of them superposed on each other) which separates the two portions, is then very warm on its inferior surface, and very cold on its upper surface. It must, of course, be very strongly electrified, negatively on the one side, and positively on the other; and this electrical condition may be constantly destroyed by the neutralization of the two opposite electricities, which operate across the cloud itself, without however ceasing to exist, since the cause which produces it continues to act, and is ready to reproduce it as rapidly as it disappears. Here, then, we perceive the two strata of clouds of which M. Lecoq speaks; the wind ere long separates them; the atmosphere is speedily filled with clouds, some of which are negatively electrified, and the others positively, without including those which are electrical through the influence of others.

But why, it may be inquired, does this distribution of temperature, which produces so great an accumulation of electricity in the atmosphere, for the most part also produce the phenomenon of hail? In answer to this question, we must recollect, that the thicker the layer of clouds which intercepts the heat from the earth, the colder is the upper portion of the atmospheric column. Its temperature ought to be decidedly inferior to that of ice, for if the cloud completely interrupted all the terrestrial heat, it would be reduced to the temperature of the upper limit of the atmosphere, which is less than —50° Cent.; but there is no necessity it should be so low as this. It is enough that its temperature should be sufficiently low to congeal the drops of water at the upper part of the cloud, and so to freeze them as to render them capable, when impelled by the wind, as noticed by M. Lecoq, to traverse the layers of clouds, and descend towards the earth in consequence of their

weight, at the same time condensing and freezing upon their surface the vapours through which they pass. Thus, the same cause which favours the abundant accumulation of atmospheric electricity in the cloud, will also be that which most assuredly effects the formation of hail. In particular, the immense heat which is usually experienced before a thunder storm, precisely indicates the existence of an invisible stratum, or of a cloud which, placed in some part of the atmosphere above the observer, intercepts the terrestrial heat, and sends it back whence it comes, instead of allowing it to proceed into free space; consequently, the higher the temperature is raised on the surface of the earth at any given time, the more it must be depressed on the other extremity of the column, or on the other side of the cloud, and consequently there must be the greater tendency both to the development of electricity, and to the formation of hail.

Again, the hailstones once formed, enlarge more or less, according to the length of the course which the wind causes them to pursue through the atmosphere; according to the quantity of water which they meet with in this course, and, finally, according to the temperature more or less low which they possess at the moment of their formation. In winter, if they be small, it is owing to the absolute quantity of water which the atmosphere contains being much less; and since at the moment of their formation the temperature is not lower than in summer, they must clearly condense a smaller quantity of water upon their surface, since they encounter less in their passage: they then form what we call *hoar-frost* (gresil.)

We believe, therefore, that hail is formed in the most elevated regions of the atmosphere; where we besides know, from the appearance of halos, that small crystals of ice are often floating. The cloud which carries these small nuclei of hailstones on its upper surface descends obliquely towards the earth through the combined effect of its weight and of the dominant wind. In proportion as it descends, the hailstones increase in size, or diminish and are dissipated, according as they meet in their course clouds, or a dry atmosphere. In the former case, the cloud which conveys them becoming always more and more weighty, at length descends lower than all the others, as has often been remarked, and finally disperses itself upon the ground.

We shall not attempt at present to develope more in detail the ideas which we have now expressed. We should even have waited till a greater number of observations than those which we have already made had furnished us with a more solid groundwork, had not the publication of M. Lecoq presented a favourable occasion for their publication.

Edin. New Philos. Jour.

Mechanics' Register.

Cuir mâché.

Mr. Joseph Esquilant, 25, St. Alban's Street, Lambeth, has recently invented a mode of manufacturing flowers, and other articles for decorating rooms, of leather, prepared in the same manner as paper is for *papier mâché*. The advantage of using this material is, that the articles are tougher and more durable. A specimen, which was shown to us

by Mr. Esquilant, was thrown from one end of the room to the other and pulled at both ends with considerable force, without suffering the slightest injury. We trust some eminent architect will examine this invention, and patronize its author as he deserves.—*Cond.*

Architec. Mag.

The Cuba Railway.

This railway passes from the city of Havanna to the port of Batabano, on the southern side of the island of Cuba, and is eighty miles in length. The purpose for which it has been constructed, is to connect the commerce of the Havanna and the northern side of the island, and also the commerce of New Orleans and various other important parts of the northern side of the Gulf of Mexico, with the West India islands and the Spanish Main. Cuba being an island of upwards of 700 miles in length, but only about 80 miles in average breadth, and lying in a position which requires vessels from the north or the south to sail round it in order to reach the opposite sea, it was projected by the present governor of the island, that a railway should be formed for the purpose of cutting off a navigation of several days, by passing across the island from north to south. It is therefore apparent that the railway is a work of the most important kind, and will tend to improve most materially the commerce, not of the island of Cuba alone, but of the English West India Islands, and of all the countries of the West India seas.

The railway is not perfectly direct in its course from the Havanna to Batabano; as, in the commencement of the undertaking, it was thought expedient to carry the line a few miles eastward of the due course across the island, for the purpose of taking in some very rich and populous villages and sugar plantations which exist upon the way. This deviation, however, will serve as a branch, should the traffic upon the railway prove equal to the expectations of the government, and the course, at a future time, be required to be rendered perfectly direct from sea to sea.

Fifty miles of the line have been completed some months since, and a steam locomotive engine, of great power and size, has been manufactured for it, by the Messrs. Braithwaite, of the New Road. The whole of the levels and other more important works upon the remaining thirty miles, are now also completed; and the rails having been shipped from England about two months since, it is expected that the next arrivals from the Havanna will communicate intelligence of the opening of the entire line.

Lond. Mech. Mag.

East India Caoutchouc.

It is well known that a large supply of this valuable substance might be procured from India, if the same care were to be taken in gathering it as in South America. "The London Caoutchouc Company," impressed with this idea, accordingly sent to India an offer of a premium of fifty pounds for the first hundred weight of East India caoutchouc which should be shipped for England. When the offer arrived, how-

ever, it was somewhat of the latest; the great demand existing at home for the article had been previously heard of, and large quantities were already on shipboard; compared to which the "hundred weight" stipulated for was but a molehill to a mountain! The whole affair forms an apt illustration of the doctrine that, in commerce, the force of self-interest is far superior to that of artificial bounties. Ibid.

Minerals in Jamaica.

The expectations of the Spaniards, which appear to have been disappointed on the first discovery of Jamaica by Columbus, with respect t its mineral riches, appear to be on the eve of being realized, in our days, after an interval of more than three centuries; specimens of copper, gold, silver, lead, and iron ores, of great beauty and richness, having been received in this country from an estate in the vicinity of Kingston. The copper ore is said to yield fifty per cent. of pure metal, and hence appears to be the richest in the world: and a cargo of copper ore shipped from an estate in the parish of St. George, sold as high as £40 per ton. Besides this, a discovery of coal, of excellent quality, has also taken place, and promises to be of vast advantage to the inhabitants.

Mining Journal.

Origin of Coal.

Coal is supposed by some writers to be the remains of antediluvian timber which floated in the waters of the deluge until several mineral strata had been formed; others conceive it to be antediluvian peat bog. It was used in England anterior to the reign of Henry III; for that monarch, in 1234, renewed a charter granted by his father to the inhabitants of Newcastle, by which they were permitted to dig coal on the payment of 100*l.* per annum. Coals had been introduced into London before 1306, for in that year the use of them as fuel had been prohibited, from the supposed tendency of their smoke to corrupt the air. About the beginning of the sixteenth century the best coals were sold in London at the rate of 4s. 1d. per chaldron, and at Newcastle no more than 2s. 6d. for the same. During the ensuing century, however, they were received into such general use, that in 1648, on the scarcity of coal in London, many of the poor were said to have died from the want of fuel. The whole quantity of coal sent into London on an average of four years, has been estimated at 1,170,000 chaldrons per annum. There has been much dispute on the origin of coal, but Brogniart has given the following as the general conclusions of naturalists:—1. That coal was formed at the same time as, or after the existence of, organized bodies. 2. That this mineral when first formed was liquid, and in a great degree of purity. 3. That the same cause which produces this substance is several times renewed in the same places and under the same circumstances. 4. That the cause, whatever it may be, is nearly the same over all the earth, since the beds of coal always exhibit nearly the same phenomena in their structure and accidental circumstances. 5. That these beds have not been deposited by any violent revolution, but on the contrary, in the most tranquil manner, since the organized bodies that are found in them are often found entire, and the leaves of vegetables impressed in the slate which covers the coals are hardly ever bruised or otherwise deranged.—*Merthyr Chronicle.* Ibid.

by Mr. Esquilant, was thrown from one end of the room to the other and pulled at both ends with considerable force, without suffering the slightest injury. We trust some eminent architect will examine this invention, and patronize its author as he deserves.—*Cond.*

Architec. Mag.

The Cuba Railway.

This railway passes from the city of Havanna to the port of Batabano, on the southern side of the island of Cuba, and is eighty miles in length. The purpose for which it has been constructed, is to connect the commerce of the Havanna and the northern side of the island, and also the commerce of New Orleans and various other important parts of the northern side of the Gulf of Mexico, with the West India islands and the Spanish Main. Cuba being an island of upwards of 700 miles in length, but only about 80 miles in average breadth, and lying in a position which requires vessels from the north or the south to sail round it in order to reach the opposite sea, it was projected by the present governor of the island, that a railway should be formed for the purpose of cutting off a navigation of several days, by passing across the island from north to south. It is therefore apparent that the railway is a work of the most important kind, and will tend to improve most materially the commerce, not of the island of Cuba alone, but of the English West India Islands, and of all the countries of the West India seas.

The railway is not perfectly direct in its course from the Havanna to Batabano; as, in the commencement of the undertaking, it was thought expedient to carry the line a few miles eastward of the due course across the island, for the purpose of taking in some very rich and populous villages and sugar plantations which exist upon the way. This deviation, however, will serve as a branch, should the traffic upon the railway prove equal to the expectations of the government, and the course, at a future time, be required to be rendered perfectly direct from sea to sea.

Fifty miles of the line have been completed some months since, and a steam locomotive engine, of great power and size, has been manufactured for it, by the Messrs. Braithwaite, of the New Road. The whole of the levels and other more important works upon the remaining thirty miles, are now also completed; and the rails having been shipped from England about two months since, it is expected that the next arrivals from the Havanna will communicate intelligence of the opening of the entire line.

Lond. Mech. Mag.

East India Caoutchouc.

It is well known that a large supply of this valuable substance might be procured from India, if the same care were to be taken in gathering it as in South America. "The London Caoutchouc Company," impressed with this idea, accordingly sent to India an offer of a premium of fifty pounds for the first hundred weight of East India caoutchouc which should be shipped for England. When the offer arrived, how-

ever, it was somewhat of the latest; the great demand existing at home for the article had been previously heard of, and large quantities were already on shipboard; compared to which the "hundred weight" stipulated for was but a molehill to a mountain! The whole affair forms an apt illustration of the doctrine that, in commerce, the force of self-interest is far superior to that of artificial bounties. Ibid.

Minerals in Jamaica.

The expectations of the Spaniards, which appear to have been disappointed on the first discovery of Jamaica by Columbus, with respect t its mineral riches, appear to be on the eve of being realized, in our days, after an interval of more than three centuries; specimens of copper, gold, silver, lead, and iron ores, of great beauty and richness, having been received in this country from an estate in the vicinity of Kingston. The copper ore is said to yield fifty per cent. of pure metal, and hence appears to be the richest in the world: and a cargo of copper ore shipped from an estate in the parish of St. George, sold as high as £40 per ton. Besides this, a discovery of coal, of excellent quality, has also taken place, and promises to be of vast advantage to the inhabitants.

Mining Journal.

Origin of Coal.

Coal is supposed by some writers to be the remains of antediluvian timber which floated in the waters of the deluge until several mineral strata had been formed; others conceive it to be antediluvian peat bog. It was used in England anterior to the reign of Henry III; for that monarch, in 1234, renewed a charter granted by his father to the inhabitants of Newcastle, by which they were permitted to dig coal on the payment of 100*l.* per annum. Coals had been introduced into London before 1306, for in that year the use of them as fuel had been prohibited, from the supposed tendency of their smoke to corrupt the air. About the beginning of the sixteenth century the best coals were sold in London at the rate of 4s. 1d. per chaldron, and at Newcastle no more than 2s. 6d. for the same. During the ensuing century, however, they were received into such general use, that in 1648, on the scarcity of coal in London, many of the poor were said to have died from the want of fuel. The whole quantity of coal sent into London on an average of four years, has been estimated at 1,170,000 chaldrons per annum. There has been much dispute on the origin of coal, but Brogniart has given the following as the general conclusions of naturalists:—1. That coal was formed at the same time as, or after the existence of, organized bodies. 2. That this mineral when first formed was liquid, and in a great degree of purity. 3. That the same cause which produces this substance is several times renewed in the same places and under the same circumstances. 4. That the cause, whatever it may be, is nearly the same over all the earth, since the beds of coal always exhibit nearly the same phenomena in their structure and accidental circumstances. 5. That these beds have not been deposited by any violent revolution, but on the contrary, in the most tranquil manner, since the organized bodies that are found in them are often found entire, and the leaves of vegetables impressed in the slate which covers the coals are hardly ever bruised or otherwise deranged.—*Merthyr Chronicle.* Ibid.

Lunar Occulations for June 1838.

LUNAR OCCULTATIONS FOR PHILADELPHIA, JUNE 1838.					Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜	
Day.	H'r.	Min.	Star's name.	Mag.	from Moon's North point.	from Moon's Vertex.
9	15	54	Im. 84 p. Sagittarii	,6,	110°	131°
9	16	6	Em.		286	319

Meteorological Observations for December, 1837.

Moon.	Days.	Therm. Sun rise.	Therm. 2 P.M.	Barometer, sun rise.	Barometer, 2 P.M.	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	39	55	30.10	30.10	S.	Moderate.		Fog—clear.
	2	43	62	29.90	29 80	S.W.	do.		Fog—clear.
	3	54	58	54	54	W.	do.		Cloudy—do.
☾	4	39	45	80	84	W.	do.		Cloudy—clear.
	5	30	42	30.15	30.20	W.	do.		Clear—clooudy.
	6	29	45	20	10	W.	do.		Clear—do.
	7	30	43	5	5	W	do.		Clear—do.
	8	32	48	29.81	29.70	W.	Brisk.		Clear—do.
	9	20	21	30.00	82	E.	Moderate.		Cloudy—do.
♈	10	30	32	29.50	50	E.	Brisk.	.35	Rain—cloudy.
	11	32	34	50	60	W.	do.		Clear—cloudy.
	12	28	37	90	90	W.	do.		Clear—clear.
	13	27	40	90	80	W.	Moderate.		Clear—do.
	14	24	32	80	80	W.	do.		Cloudy—clear.
	15	18	27	30.00	30.00	NW.	do.		Clear—do.
	16	19	30	20	20	W.	do.		Clear—cloudy.
	17	22	29	10	29.00	E.	Blustering.		Snow—sleet.
☽	18	52	43	28.90	10	SW.W.	do.	2.00	Rain—shower
	19	30	36	29-60	60	SW.	Moderate.		Clear—cloudy.
	20	25	30	70	70	W.	Brisk.		Clear—do.
	21	20	27	80	83	W.	Moderate.		Clear—cloudy.
	22	20	30	90	30.00	W.	do.		Clear—partially cloudy.
	23	19	32	30.25	25	W.	do.	.3	Clear—snow,
	24	27	34	5	29.95	NW.	do.		Cloudy—clear.
	25	27	36	15	30.15	W.	do.		Clear—do.
	26	33	50	29.85	29.85	W.	do.		Cloudy—clear.
	27	23	34	30.30	30.30	SE.	do.		Clear—do.
⊗	28	23	39	29'96	29.96	E.	do.		Partially cloudy—do. do.
	29	24	32	30. 5	30. 5	SW.	do.		Clear—lightly cloudy.
	30	29	46	29.96	60	W.	do.		Clear—clear.
	31	35	41	30.00	10	ENE.	do.		Clear—do.
	Mean	29.13	38.45	29.90	29.86			2 38	

	Thermometer.	Barometer.
Maximum height during the month.	62.00 on 2nd.	30.30 on 27th,
Minimum do.	18.00 on 15th.	28.90 on 18th.
Mean do.	33.79	29.88